SCIENCE

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PONCELET POLYGONS[1]

THERE is nothing which can not be known. Such at least is the postulate of science. Wide as is the universe of matter, numberless as are the objects and the events in the world of either dead matter or living organisms, yet the scientist must have faith that all can be observed, classified, named; that a finite number of terms and a finite system of laws will suffice ultimately for the summing up of what we call the external universe. A dream, if one regards it as a positive expectation! Yet how far it has gone in the direction of realization in certain obvious horizons! In our solar system it is not frequently that a major planet is discovered. In the chemist's domain, does any one concede that the unknown elements are more in number than the known? Does any physicist really expect to come upon a new kind of activity at all comparable in importance with the Röntgen rays? Though the ideal of complete knowledge and perfect explanation may be destined never to be reached, yet how prone are we to imagine that it must be not far away!

In a certain contrast to the material world stands the world of intellect and reason, a contrast partly at least fictitious, but also in part intrinsic. It is in this world that geometry exists. Whatever else be true about geometry, it is plain from experience and from history that its objects are ideas or notions; that they are comple-

[1] Address of the retiring vice-president and chairman of Section A of the American Association for the Advancement of Science, Columbus, December 30, 1915.

mentary to, not extracted from, the material world. Knowable they are, therefore, by their very constitution. But who can ever conceive of them as limited in number? Who can imagine that ever in the future it could come to pass that there should be no more geometric concepts to be investigated; that a point might be attained where the mind of the mathematician should rest satisfied, all its curiosity appeased?

Connected with this contrast in the source of its objects is the slowness with which new objects in geometry emerge and diffuse into general knowledge. Called into being by shifting stimuli, multitudes of new systems of relations are invented and named and investigated; but most of them are speedily forgotten (or perhaps only dimly apprehended even by the discoverer), and very few in a century are those which survive to become the valued heritage of later generations.

There are many occasions when we meet to discuss only what is new. The present, however, is a fitting occasion for reviewing together some of the treasures handed on to us by geometricians of the past, and for stimulating our own ardor by the rehearsal of the fortunes and successes of earlier workers in our part of the field of science. The polygons of Poncelet were new a hundred years ago, and are not yet forgotten, but seem rather to attract increasingly the interest and attention of geometricians. I invite you to enjoy with me, since though not unknown they are not yet in the class of familiar objects, a rapid survey of their character and development.

For many centuries before Euler students of geometry had found interest in circles inscribed in a triangle and circumscribed to it. Usually their centers do not coincide. One circle may be kept stationary, while the triangle varies, and with it vary also the center of the other circle and its radius. Euler may have been the first to write out the relation that connects these three quantities, the two radii and the distance of the centers: $R^2 = 2Rr + d^2$, or it may have been discussed a hundred times before. Publication of this relation led to the study of analogous relations for polygons of more sides, Fuss in St. Petersburg, and some years later Steiner in Berlin, carrying the problem farthest, finding results for polygons of 4, 5, 6, 7 and of 8 sides. The case of regular polygons, for which the inscribed and circumscribed circles are concentric ($d = 0$) is elementary, and will always stimulate interest in the more general problem.

While attention was directed to finding an algebraic relation corresponding to a given geometric diagram, for a long time no one seems to have inquired whether this relation was merely a necessary condition, or whether it might also be a sufficient condition for the construction of the diagram. If two circles are drawn, satisfying the condition for a triangle: $R^2 = 2Rr + d^2$, can one always determine the triangle inscribed in the circle radius R and having its sides all tangent to the circle of radius r? And is there only one such triangle in each case, or some finite number greater than one? What of the case where the triangle (or polygon of 4, 5 or more sides) is regular—is it exceptional that for that case there are an infinite number of polygons which satisfy the requirements, provided there is one such?

It is not easy to apprehend the state of geometric knowledge in 1796, when Fuss wrote on this subject. He certainly supposed that a triangle could occur singly, and was unaware that others can always be inscribed and circumscribed to the same pair of circles. It would seem as though the roughest kind of experimentation would have shown the truth, or at least would

have given grounds for a hypothesis. But Fuss limited his investigation, so Jacobi states, to the case where the polygon is symmetrical with respect to the common diameter of the two circles. Symmetrical-irregular polygons, he calls them; and this Fuss supposed to be essentially a restriction upon the generality of the problem, and hence he believed that he had solved only under limitations the problem proposed. This misapprehension apparently persisted for 26 years, until the appearance in 1822 of Poncelet's memorable work: "Traité des Propriétés Projectives des Figures." Indeed there is indirect evidence to this effect in an essay by Poncelet himself, of the date 1817, in which he challenges his correspondent to solve the problem of inscribing in a given conic a polygon of n sides, the sides to be tangent to a second given conic. This problem as stated is, as we now know, misleading, implying that there is a solution, and that the number of solutions is finite. Poncelet would hardly have ventured to publish such a problem had he not been sure that the mathematical public of that day would accept it in good faith.

It would be quite certain also, even if we had no direct knowledge of the fact otherwise, that the relations of collinearity and correlativity or reciprocity with respect to a conic were not at all commonly understood prior to 1822. The employment of transformations to derive one solution of a problem from another was not yet a recognized preliminary to all discussion. The student of conics to-day will reflect at once that two conics not specialized in situation have one self-polar triangle in common, and are transformed into themselves by three collineations or projectivities besides the identity, and are transformed simultaneously into each other by four reciprocities or polarities with respect to a third fixed conic. Thus to-day we should see in advance that any one triangle, or one pentagon, inscribed in one conic and circumscribed to another, implies seven others of the same sort. Solutions of Poncelet's problem must occur at least in sets of eight; but this fact, apparent from Poncelet's own discoveries, appears to have escaped his attention, and still less was it present to the minds of his contemporaries.

Knowledge of the investigations of Fuss and of Euler would have been almost useless to Poncelet. For the far superior generality of his problem, that of two conics in place of two circles, his method of projection is responsible. This allowed him to use metric properties of circles and draw conclusions concerning any two curves of the second order. But the discovery of his famous theorem on polygons was nothing less than a stroke of genius. Many have been quoted as authors of the saying that invention or discovery is the principal thing in geometry, while the proof is a relatively easy matter. In this case, however, the proof also is ingenious, carried on by the exclusively synthetic method. But the perception of the theorem, preceding its proof, escapes explanation from anything that had gone before. Were that his only contribution to our knowledge of geometry, it would ensure him grateful recognition from later students—as the compeer of Apollonius who gave us the foci of a conic, Desargues who first perceived poles and polars, Newton who described the organic construction of conics, and the immortal Pascal with his hexagon. Let us rehearse the theorem which gives a generic name to Poncelet polygons.

Of two given conics, call one the first and consider its points; call the other the second and consider its tangents. Form a broken line by taking a point of the first curve, a line of the second that passes

through it, then another point of the first on this line, and so forth. It may be that this process will close, the last line passing through the first point. If it does close, forming a polygon of n sides with vertices on the first conic and sides tangent to the second, then every point of the first is a vertex of one such closed polygon, and every tangent of the second is a side of one such polygon of n sides.

That is the first part of the theorem. The second is this. Diagonals of all these closed polygons, which omit the same number of consecutive vertices of the polygon, are tangent to a fixed third conic; and the dual statement is true concerning points of intersection of non-consecutive sides. *This latter part of the theorem is true even if the polygon is not closed.* From some points of view this scholium exceeds in importance the principal theorem.

These statements give us a specific attitude toward the conics. We look upon the first as a groove prepared to guide a set of sliding points, and the second as a directrix for lines joining the points. If the lines are indefinitely extended, there will be outlying systems of crossings; a first extra set whose motion will describe a first extra conic; a second extra set with its conic locus, and so forth. The case where the polygon is closed is that in which one of these extra loci coincides with the first conic.

We may digress to notice a curious fact. The sides of an inscribed hexagon meet in 15 points, namely, six on the conic, three on the Pascal line and six which we may term for the moment extra points. These six extra points are vertices of a hexagon *circumscribed* to a second conic. If now the first hexagon, already inscribed to one conic, becomes circumscriptible, then the hexagon of the extra points, already circumscribed to a conic, becomes inscriptible to another. This separation of two properties which occur together in all polygons of the Poncelet type is a situation deserving further attention.

To return to Poncelet: His discovery of the mobility, or the infinite multitude, of these polygons upon two fixed conics, published in 1822, must have seemed to mathematicians of that day as startling as the announcement of a new genus of vertebrates by a traveler returning from distant lands. Its exact character had to be ascertained and settled. The possibilities of variation must be examined; as, for example, whether all the sides of the polygon need be required to touch the same conic. Here it was seen by Poncelet himself that if all conics concerned pass through the same four basis points, then it is sufficient for the purpose if each side in its order touches its own assigned conic—all the vertices will still be movable on their common track. After this, it seems like a new proposition to assert that the order in which the fixed conics are touched by successive sides may be varied, and still the polygon will close in the same number of sides. And it is a new proposition, as announced within the last few years by Rohn, provided not merely their order, but also their *cyclic* order, is altered. Whether in this generalized figure the extra points still describe loci of the same family, that I do not remember seeing demonstrated.

The fertile mind of Jacobi seized the germ idea of periodicity in this closed figure, so closely resembling sets of arguments of the elliptic functions differing by aliquot parts of a period. This suggestion was the more natural because of the geometrical diagrams current in the definition of elliptic arguments. Only six years after the date of Poncelet's book, we find (1828) in Crelle's *Journal,* Vol. III., Jacobi's brief and elegant essay on these polygons for the

case of two circles. Steiner had but recently written on the same topic, apparently unaware that it had been approached before. Jacobi was able now in the light of Poncelet's theorem to vindicate the claims of Fuss to priority, since his *irregular-symmetric* polygons were particular cases in every infinite set of Poncelet polygons on the same pair of circles. Jacobi further applies the recursion formulæ arising in the iterated addition of a constant to the elliptic integral of the first kind. Note his compact and expressive formulæ. If the radii are R and r, the distance of their centers a, and the n-gon encircles the centers i times before closing, all this is duly contained in the three formulæ

$$\int_0^{\alpha} \frac{d\varphi}{\sqrt{(1-kk\sin^2\varphi)}} = \frac{i}{n}\int_0^{\pi} \frac{d\varphi}{\sqrt{(1-kk\sin^2\varphi)}};$$

$$\cos\alpha = \frac{r}{R+a};$$

$$kk = \frac{4aR}{(R+a)^2 - rr}.$$

By this apparatus he verified the conditions already calculated for the closure in 3, 4, 5, 6, 7 sides, and confirmed for 8 sides the result of Fuss in opposition to Steiner's formula.

Certainly there is something satisfactory in seeing similar steps in geometric construction replaced by successive additions of one fixed quantity to an elliptic argument. But the problem was originally one of algebraic geometry, in so far as the conic represents a quadric form and the conditions of incidence and contact are algebraic; hence it was to be expected that there would be investigators who would not be satisfied with this transcendental elucidation of Jacobi, but would insist upon algebraic treatment throughout. Moreover, when once the projective treatment of figures had acquired prestige in pure geometry, it made inroads rapidly in the analytic territory. It was then desirable to solve the problem in its generality, for two conics whose equations are given arbitrarily, not restricting them to be circles; and to use processes and nomenclature that would not be affected by linear substitutions upon the coordinates or collineation. These last two desiderata appealed to Cayley not long after 1850, and from time to time he worked out parts of the problem: to express in invariants of two quadrics the condition that a broken line inscribed in the one and circumscribed to the other shall close in n sides. The results are not stated in terms of *rational* invariants, but they have the very great merit of being quickly and easily perceived, and of requiring only invariant terminology. The discriminant of a quadric is perhaps the best known of all invariants. For a quadric with one linear parameter he requires the discriminant to be calculated—namely for $F + K\phi$, where $F=0$ and $\Phi=0$ are the equations of the two conics, respectively. This is of degree 3 in the parameter.

$$D = A + bK + cK^2 + dK^3.$$

Next, the square root of this discriminant is developed formally in ascending powers of K;

$$\sqrt{D} = \sqrt{A} + B_1K + B_2K^2 + C_1K^3 + C_2K^4 + D_1K^5 + D_2K^6 + \text{etc.}$$

The conditions of closure are now, in form at least, simplicity itself, namely, the vanishing of a determinant whose constituents are coefficients in this development. For an odd number of sides in the polygon, the leading constituent is C_1; for an even number, C_2, thus:

For 3 sides,

$$C_1 = 0,$$

For 5 sides,

$$\begin{vmatrix} C_1 & C_2 \\ C_2 & D_1 \end{vmatrix} = 0,$$

For 7 sides,

$$\begin{vmatrix} C_1 & C_2 & D_1 \\ C_2 & D_1 & D_2 \\ D_1 & D_2 & E_1 \end{vmatrix} = 0;$$

For 4 sides,

$$C_2 = 0,$$

For 6 sides,

$$\begin{vmatrix} C_2 & D_1 \\ D_1 & D_2 \end{vmatrix} = 0,$$

For 8 sides,

$$\begin{vmatrix} C_2 & D_1 & D_2 \\ D_1 & D_2 & E_1 \\ D_2 & E_1 & E_2 \end{vmatrix} = 0, \text{ etc.}$$

When one of these conditions is satisfied, the corresponding polygons are inscribed in the conic $\Phi = 0$, and circumscribed to the other. To test two given conics by this method would evidently involve considerable labor, but it would have the merit of being straightforward work, all of one kind—the calculation of determinants. Only one such would enter, the square root of the discriminant of the conic that carries the tangents, hence rationalization would be easy. It is hardly likely that results more elegant will be reached by any method; yet there are later researches, that I have not yet been able to examine, highly praised by reviewers. It does not appear that Cayley has given any account of the modifications necessary in these conditions when the sides touch different curves of the pencil.

Two other questions, however, were started by Cayley. The first is that of the relations in terms of the two invariant cross-ratios of the two conics—those belonging to the four common points or the four common tangents in the one conic and in the other. Conditions that exhibit a recursive law of formation in one domain of rationality are quite certain to do the same in a different domain, and Halphen has carried out the solution of this problem to completion (if that is a possibility) in his Elliptic Functions, Part 2. His interest in the geometry of the figure led him to propose the question, How many conics in a *linear system* can serve as loci for the vertices of a polygon of m sides, the sides to be tangent to a fixed conic? The answer is, for a polygon of 3 sides, 2 conics; for 5 sides, 6 conics; for 6 sides, 6 conics; in general

$$\frac{m^2}{4}\left(1-\frac{1}{p^2}\right)\left(1-\frac{1}{q^2}\right)\left(1-\frac{1}{r^2}\right)\cdots,$$

where all the prime factors of m are p, q, r, etc.

Cayley's second new problem in this connection was one concerning curves other than conics. If m_i denotes the order; μ_i the class of any curve, and it is required to describe a closed polygon beginning from a vertex A upon a curve of order m_1, drawing a side that shall touch a curve of class μ_1 and meet in a second vertex a curve of order m_2, and so on, then the number of solutions is twice the continued product of the m's and the μ's. This implies that the curves are all different, and calls for modification when coincidences are required.

Cayley initiated, but Hurwitz carried to completion, an algebraic explanation of the mobility of the Poncelet polygon whenever it actually exists. This, which is much the simplest method of attack, is by means of a correspondence upon a rational curve or line. The conic is a rational curve, and its points or its tangents can be given by quadric functions of a single parameter. In the presence of a second conic to carry the tangents, any point of the first corresponds primarily to two others, namely those two points in which the first conic is cut again by tangents to the second conic drawn from the first point. Such a correspondence is symmetrical two-to-two or (2, 2). Points further removed from any given first point are related to it secondarily, or more remotely, by a derivative

(2, 2) correspondence between the parameters. Hence there should be $2+2$ closures, whatever the degree of remoteness demanded between first and last points. But exactly four, improper indeed, are supplied by the participation of the four common points or the four common tangents. The relevant algebraical equation for the parameters will always have four roots relating to improper or degenerate polygons. If it has any more than these four, it admits all parameter-values as roots. Hence one actual *proper* polygon of m sides proves the existence of countless others. This brief but conclusive reasoning gives the problem its true setting in advance, but leaves for other methods the question of the existence of the all-important *first proper* polygon.

Gino Loria, in his memorable work, *Il passato id il presente delle principali teorie geometriche,* makes mention of these papers of Hurwitz at the climax of his paragraphs on theorems of closure; and says of the earlier essay, that in it "we do not know whether to wonder more at the immensity of the view, or at the perfection of its beauty; and so with this we bring to an end this digression, for which we should seek in vain a close more worthy." I have preferred however to summarize it earlier, in order to make clear with the greater brevity certain other applications that depend upon the same principle.

It is hardly needful to remind you that the (2, 2) correspondence leads inevitably to elliptic functions, as Euler long ago pointed out. If we picture the situation by means of a Riemann surface, it must have two leaves and four branch-points; and is therefore of deficiency one, whence all functions belonging to the surface are doubly periodic. Of course in the foregoing survey we have been thinking mainly of real points and lines and loci, and so have neglected the second period—the first being real. The use of elliptic functions enables us to understand the situation involving imaginary arguments, as when the point locus is completely enclosed by the line-locus, so that a *real* polygon is obviously impossible, and yet the invariant conditions may be satisfied. The one essential premise is in every case, that the things under consideration are algebraically connected, two values of either to every one value of the other.

First let me recall the chain of circles devised by Steiner, most recently so interestingly treated by Professor Emch by the aid of his mechanical linkages. Let two circles enclose a ring-shaped area in the plane, and draw any one circle in that ring tangent to the first two. Let a second be drawn touching both the directors and the last mentioned circle, then a third touching in the same way the second, and so on. If a last circle ever appears in the series, say the nth in order, touching the first one, call the chain closed. This chain is now like the Poncelet polygon in the essential feature, in that every member (circle) is preceded by one and followed by one definite member of the series: the correspondence is certainly algebraic and (2, 2). Therefore the chain will close with n circles, no matter what one be selected for the first. Both Hurwitz and Emch have stated weaker conditions that lead to the same conclusion; but it would seem, if the analogy of the polygon porism is valid, that many other variations of conditions ought yet to be attempted.

There are Steiner's polygons on a plane cubic, with alternate sides passing through one of two selected fixed points on the curve. This curve, with points represented in elliptic functions of a parameter, might seem out of place among conics and other rational curves, but the next example will

remind us of the natural connection. Let the base points be A and B. Choose at random a point 1 on the cubic curve, and draw in their order the lines $A12$, $B23$, $A34$, $B45$, etc., all the numbered points lying on the curve. If this series never closes, the same would be true if point 1 were chosen elsewhere; or if it does close after $2n$ sides, the same will be true for every position of point 1. Here of course the relation of the base points is decisive, and the fact that elliptic arguments of three points in a line sum up congruent to zero makes the proper choice of the point B a mere matter of arithmetic, *i. e.*, division of a period of the functions for that cubic curve.

Projection from any point of a twisted quartic curve gives in the plane a cubic curve. But also from one of four special points, the quartic projects into a conic double. At the same time the generators of any quadric surface containing the quartic curve are projected into tangents of a second conic. Any Poncelet polygon of $2n$ sides on those two conics is then the projection, if we please, of a system of generators from the two families on the quadric, alternating, n from each family. On the plane cubic the same set of lines would be projected from a point P as the alternating sides of a Steiner polygon, where points A and B are projected by the two generators through the point P. As all generators of one family meet every generator of the other family, this makes clear the intimate connection between Steiner's and Poncelet's polygons.

To vary the object, look at Hurwitz's plane quartic curve with two cusps and a node. It has two inflexions and a double tangent, and is therefore of class 4, dual to itself. On such a curve let a tangent be drawn, and through each intersection with the curve the second possible tangent from that point; we have clearly another (2, 2) correspondence, and are prepared for the discovery that closure in a finite number of sides, starting from any one tangent or vertex, implies closure in the same number of sides, whatever the point of beginning. In place of two conics we have here the one quartic, but the essential (2, 2) correspondence is in evidence, and the same mobility of figure results from it.

Not to be confounded with these examples is the particular plane quartic curve investigated by Lüroth, which admits the inscription of a complete pentagon. There is a resemblance, it is true, in the fact that it too is a problem of closure, and in the variability of the pentagon. For if the sides of one such pentagon are given by equations, $p=0$, $q=0$, etc., so that the quartic equation is

$$pqrs + qrst + rstp + stpq + tpqr = 0,$$

then these five sides are tangents of a unique conic, and every tangent to that conic is one of a set of five constituting an inscribed pentagon of the same quartic. But the correspondence is (4, 4), and the circumscribed locus is not a rational curve. It is, however, in one direct line of descent from Poncelet's triangles. Those triangles mark, on the conic-bearing tangents, sets of three points in involution; and any cubic involution of tangents has for locus of the vertices of its triangles a second conic. So when the number of tangents in each set is increased, we have the *involution-curves.* It is an involution of the fifth order which generates for its locus this quartic curve of Lüroth, each tangent intersecting the four in its own set. Such an involution is the equivalent of a (4, 4) correspondence, which might in special cases degenerate into two (2, 2) correspondences, and carry Lüroth's quartic curve with it into two distinct conics, each containing a system of inscribed Poncelet triangles.

A somewhat different kind of curve arising from a (2, 2) correspondence was that investigated some years ago by Holgate. Starting with a pencil of conics, normalized to a system of coaxial circles, he gave to every point in their plane an index, usually ∞, but for certain points finite. From the point any line is drawn. It touches two circles of the system. One of these has a second tangent through that same point, and that tangent touches a third circle, etc. If after n steps of this kind the first line is reached again, the index of that point is n. Holgate determined the locus of points whose index is 3 as a parabola; that for index 4 as a nodal quartic, and laid out the general method for higher indices. One should react from this experiment to something more like the original Poncelet object; to one fixed conic as support of its tangents, and a double infinity or net of conics. A simple infinity of conics in this net would contain Poncelet triangles with respect to the fixed conic: their index would be 3, and their envelope would take the place of Holgate's parabola. And for the dual problem, there is ready at hand the well-known system of confocal conics, in which the indices of all straight lines should be studied, and the envelopes of lines for each integral index.

The number of different treatments of this same problem increases, not rapidly, but steadily; its fascination is exerted upon the successive generations of mathematicians, and some of their works of art stand out from the mass, some for a little time, some longer. I shall pass over most of them, these images, in geometric shape, of the algebraic (2, 2) correspondence; and describe only one more related object, an image of a (3, 3) correspondence. Franz Meyer studied it and elaborated it in detail, years ago as a docent at Tübingen, in his book on *Apolarität*. Studying the quartic involution, he began with the (3, 3) correspondence among points upon a twisted cubic curve, the simplest rational curve in space of three dimensions. For comparison, remember the cubic involution on a conic in two-space. There we had this theorem on Poncelet triangles: If a conic be circumscribed to one triangle which is circumscribed about a fixed conic, then there are ∞^1 other triangles similarly related to the two conics. Meyer found the theorem, surprising by contrast: If a tetrahedron be formed of four planes which osculate one fixed cubic curve in three-space, and a second cubic curve be passed through its four vertices, then that pair of cubics may have, or *may not have,* a second tetrahedron similarly related to them. If, however, there is a second tetrahedron, then there is a simply infinite set of such. Many other remarkable facts in the geometry of twisted cubic curves he developed, most of which still wait for diffusion among the geometric public.

Such a discrepancy between conic and cubic does not exist in regard to periodic sets of lines and planes, respectively, of period seven. Whether it is found for periods five and six, no one has yet undertaken to determine. Yet a cleavage so marked, and so unexpected, is certainly a challenge to geometricians to explore further the so-called *norm curves* of hyperspace, and the involutions of point sets of low orders upon them.

Also the half-forgotten fact deserves recognition and exploitation, that all those Poncelet systems are associated with *linear involutions* upon rational curves. In that feature, possibly, lies even more promise of generalizations and discoveries than in Jacobi's brilliant and beautiful depiction by the aid of periodic functions.

Not every creation of the geometric mind finds an environment ready in which it can

live and grow. Some remain, immortal but alone, like the ancient theorem of Pythagoras or perhaps in recent years Morley's Pentacle, that creation of tantalizing beauty and illusory simplicity. Most new ideas in geometry die early, or pass, by publication, into the condition of mummies or fossils; let our grateful recognition and praise follow then those fortunate worthies like Poncelet, whose genius has given us the fruitful ideas, problems and theories with a significance stretching far beyond their accidental first form, reappearing through the years in new embodiments, and so achieving a life if not perpetual, at least as long enduring as the present era of intellectual culture.

H. S. White

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THE CONTEST WITH PHYSICAL NATURE[1]

I fancy that if Christopher Columbus is able at this time to survey this world and see what is happening that he is well pleased at his venturesome voyage. While the nations of the world that he left have their knives at each other's throats the peoples of this new world have sent their most learned men, their philosophers, their scientists, inventors and engineers to talk with one another as to how this new land may become wiser, richer and be made more useful. This is surely a contrast. It is a condition for which my knowledge of history offers no parallel.

There are times I know when nations who believe in themselves must fight. But let us not delude ourselves with the notion that civilization is the product of arms. The only excuse for war is to secure peace, that men of thought, resourcefulness and skill may have opportunity to make themselves masters of the secrets of nature.

For the real battle of the centuries is not between men or between nations or between races. The one fight, the enduring contest, is between man and physical nature.

There is no denying the fact that we live in a world that is hostile and secretive. It is organized to destroy us if it can. Our enemies have cunning and ferocity. We have but to fold our arms and the beasts, the flies, the rats, the mosquitoes and the vermin would make us their easy prey. And if they could not win by force, they would bring death by starvation. This world was made for a fighting man and for none other. Softness is not to be our portion, because nature knows no holiday. So man must battle with nature that he may secure that physical peace necessary to give his spirit a chance to show itself in things of beauty and deeds of goodness.

And this is what we call civilization—this triumph over the down-pull of nature. We make her yield. We master her secrets. With wooden club and stone axe, with bow and arrow and with fire man mastered his wild enemies and then with seed and water man mastered the surface of the earth. The sea challenged him and he discovered the floating log, the paddle and then the sail, until he made himself master also of the surface of the sea. These things it took ages to do. Nature revealed nothing. Man had to observe and reflect that he might discover or invent. Was there ever such a discovery as that a planted seed would sprout and yield? Or that the wind would drive a hollowed log?

But these things happened long ago. And now we have made not only the surface of the land and sea our own, but their depths as well. The wind not only fills our sails, but we master the air itself. We make our own lightning and harness it to work for us, to push and to pull, to lift and to turn. We have found the great secret that nature can be made to fight nature. But we must fight with her for our weapons. They are not handed to us; they are hidden from us. If man is to have dominion over this earth, he is committed to an unending search. He must bore and burrow, dig and blast, crush and refine, distill and mix, burn and compress until he forces nature to yield her locked and buried treasures.

[1] Address before the Mining and Geological Section of the Pan-American Scientific Congress.

Nature would have man isolated, but he triumphs over her with billets of steel and threads of copper. He swings a hammer and an engine is made that makes him neighbor to the world. He whispers to a wire which shouts the spoken word into space.

Nature would have a limit to the soil's supporting strength, but man robs the air of its nitrogen and the rocks of their phosphorus and potash to revivify the unwilling earth.

Nature would have man the victim of insidious enemies that stop or clog the human machine, but man distills from the buried carbons agents that stay destruction for a time, and now man has found a mineral which gives promise of opening the way into a new world of mysterious restoration.

This is a glorious battle in which you are fighting—the geologist who reads the hieroglyphs that nature has written, the miner who is the Columbus of the world underground, the engineer, the chemist, and the inventor who out of curiosity plus courage, plus imagination fashion the swords of a triumphing civilization. Indeed it is hardly too much to say that the extent of man's domain and his tenure of the earth rest with you.

F. K. LANE

DEPARTMENT OF THE INTERIOR

DANIEL GIRAUD ELLIOT

IN the death of Daniel Giraud Elliot, which occurred on December 22 last, after a short illness from pneumonia, science has lost a distinguished ornithologist and mammalogist. Dr. Elliot was born in New York City, March 7, 1835, and had therefore nearly completed his eighty-first year. He prepared to enter Columbia College in the class of 1852, but delicate health prevented his taking a college course and led him to seek for several years a mild winter climate, during which he visited southern Europe, Egypt, Palestine, Turkey, the West Indies and Brazil. In 1906 he was honored by Columbia University with the degree of Sc.D. From an early age his interest in natural history was intense, and in its pursuit he traveled widely and spent many years in Europe, chiefly in Paris and London. For some years before his death he was the dean of American zoologists, exceeding in age his lifelong friend, Dr. Theodore N. Gill, by two years. His primary interest for many years was ornithological, and he was the author of many folio monographs of birds, expensively illustrated with handcolored plates; during the last twenty years he devoted his time to the study of mammals, which became almost exclusively the subject of his researches.

In his early days he formed a notable collection of North American birds—the best private collection then extant—which later was secured by the American Museum of Natural History, forming its first collection of birds and the nucleus of its present magnificent collection. At this time (in the later sixties) George N. Lawrence, a much older man than Elliot, was the only working ornithologist in New York, while John Cassin, of Philadelphia, and Professor S. F. Baird, of Washington, were the only other prominent ornithologists in America.

Dr. Elliot's first publication of note was his "A Monograph of the Tetraonidæ, or Family of the Grouse" (New York, 1864–1865), a work in imperial folio with 27 handcolored plates. This was followed two years later by "A Monograph of the Pittidæ, or Family of the Ant Thrushes" (New York, 1867), also in folio with 31 colored plates. Soon after appeared his "The New and Heretofore Unfigured Species of the Birds of North America" (New York, 1866–1869), in two imperial folio volumes with 72 colored plates. These were soon succeeded by "A Monograph of the Phasianidæ, or Family of Pheasants" (New York, 1872), also in two folio volumes with 48 colored plates. These works, mainly illustrated from his own drawings, were all brought out in America and their preparation marks the period prior to his long sojourn abroad, beginning in 1869, where similar magnificent works were prepared and published in London. These are: "A Monograph of the Paradiseidæ, or Birds of Paradise" (folio, London, 1873, with 37 colored plates); "A Monograph of the Bucerotidæ, or Hornbills" (folio, London, 1876–1882, with 59 colored plates); "A Mono-

graph of the Felidæ, or Family of the Cats" (folio, London, 1883, with 43 colored plates). These works were not only important contributions to science but as works of art were at the highest level of such publications and rendered their author famous throughout the world, winning for him many decorations from European governments. He was himself an artist of no ordinary attainments, but he sought for his illustrations the best talent available abroad, including such eminent draughtsmen as Wolf and Keulemans.

During this period of nearly ten years abroad he was a frequent sojourner in Paris, in order to avail himself of the rich treasures of the famous natural history museum of that city, and became thus intimately associated with many of the leading French zoologists. Through his long residence in London he participated in the scientific activities of the British Ornithologists' Union and the Zoological Society, and for a time was a member of the Publication Committee of the latter. In his recent "In Memoriam" of the late Philip Lutley Sclater,[1] for so many years the efficient secretary of the Zoological Society and also editor of *The Ibis,* he has given a most enchanting reminiscence of the great naturalists who were in that day at the height of their activities and renown, but who have now, with the single exception of F. Ducane Godman, preceded Elliot to the great beyond.

Although the labor of getting up his great illustrated monographs must have been absorbing, he found time to prepare many technical papers on birds, which were published at frequent intervals in *The Ibis* or in the *Proceedings* of the London Zoological Society. At this time he was especially interested in the Trochilidæ, or Hummingbirds, the outcome of which was his "A Classification and Synopsis of the Trochilidæ," a quarto memoir of about 300 pages, with numerous text illustrations, published in the *Smithsonian Contributions* (Washington, 1879).

Elliot's active temperament never permitted him to remain long idle. Soon after his return from abroad he became one of the authors of the "bird volume" of Kingsley's "The Standard Natural History," published in 1885, to which he contributed the parts on the Gallinæ, the pigeons and the hummingbirds, and also began work on a new edition of his "Monograph of the Pittidæ." Since the publication of the first edition in 1863, the number of species of the group known to science had nearly doubled, and in preparing the new edition the text of the first was wholly discarded, only a few of the plates being retained in the second, which now included 51 colored plates with wholly new and greatly extended text. It was published in London by Quarich (1893–1895).

Another outcome of his long interest in the Trochilidæ was the formation while abroad of a collection of these "gems of ornithology," which he brought with him on his return to New York early in 1883. This collection, then probably unsurpassed by any other, he later (in 1887) presented to the American Museum of Natural History, where it has since remained as a standard reference collection for the group. At about this date Dr. Elliot's extensive and well-selected ornithological library passed to the museum by purchase. It contained many rare as well as expensive works, and for the first time the museum came into possession of a reasonably adequate library of ornithology.

In 1894 Elliot became curator of zoology at the Field Columbian Museum at Chicago, from which office he resigned in 1906 and returned to New York. During his curatorship at this institution the zoological department at the Field Museum made rapid strides through his energetic efforts, and it was also a period of marked activity in his literary career. In 1896 he made an expedition to Africa in the interest of this museum, passing through Somaliland and Ogaden on his way to the Boran country, where his work was checked by serious illness. He succeeded, however, in bringing back a large collection of birds and mammals, which became not only the basis of important exhibits in the museum but of important papers giving the results of his explorations. He later made a difficult

[1] *The Auk,* XXXI., January, 1914, pp. 1–12.

expedition to the Olympic Mountains in Washington, also fruitful in zoological results.

During his curatorship at the Field Museum he prepared and published under its auspices several important handbooks on North American mammals, an undertaking that might well have taxed the courage and energies of a much younger man. These are: "Synopsis of the Mammals of North America and the Adjacent Seas" (1 volume, large 8vo, 1901); "The Land and Sea Mammals of Middle America and the West Indies" (2 vols., large 8vo, 1904); "A Check List of the Mammals of the North American Continent, the West Indies and the Neighboring Seas" (1 vol., 8vo, 1905); "A Catalogue of the Collection of Mammals in the Field Columbian Museum" (large 8vo, 1907). The first two of these works form a handbook to all the mammals of North America and adjacent islands, with the cranial characters of each genus well illustrated by excellent half-tone cuts of natural size, while the text gives brief descriptions and full references to the original descriptions. While open to criticism, as such work must always be, they have proved of great utility not only to amateurs but to experts.

On leaving the Field Museum he set out upon a work of so much difficulty and magnitude that it seemed an almost audacious undertaking, which some of his friends feared would prove beyond his strength. This is his "A Review of the Primates," begun in 1906 and completed in 1912, and published in three volumes by the American Museum of Natural History, with 11 colored plates of animals and 32 half-tone plates of skulls, the latter all natural size, and with a perfection of detail not previously attained. Soon fully realizing the seriousness of the undertaking he sailed for Europe in April, 1907, to visit all of the principal museums abroad in order to study the actual types of the species and such other material as bore upon the subject. After visiting the museums and zoological gardens of Europe he passed on to Egypt, India, China and Japan, returning to New York after an absence of eighteen months, with an immense store of notes and manuscripts for future elaboration. After the work had greatly progressed he found it necessary to revisit the museums of Europe to settle many still doubtful points. He labored at his great task incessantly for at least nine months of each year, year after year, with indomitable industry and perseverance till at last it was completed for the press. In a work of this nature it would be rash to expect perfection; it is essentially sound in principle and method, and if lacking somewhat in details, it will long be of invaluable service to all who may follow in the same field.

Besides the works already mentioned, Dr. Elliot has many lesser volumes and a long list of technical and occasional papers to his credit. During the years 1895–1898, he published three casual volumes, of a somewhat popular character, on the game birds of North America, for Elliot was an ardent sportsman as well as a naturalist. These books, which have met with much favor, are entitled: "North American Shorebirds: a History of the Snipes, Sandpipers, Plovers and their Allies" (8vo, New York, 1895); "The Gallinaceous Game Birds of North America" (8vo, New York, 1897); "The Wild Fowl of the United States and British Possessions, or the Swans, Geese, Ducks and Mergansers of North America" (8vo, New York, 1898).

Dr. Elliot was one of the founders of the American Ornithologists' Union (1883), its president for two years (1890–1891), and an active member of its council for twenty-eight years (1887–1915). He was also a member of the British Ornithologists' Union, the Zoological Society of London, a fellow of the Royal Society of Edinburgh, and an honorary or corresponding member of many scientific societies in Europe as well as in America.

In the early years of the founding and organization of the American Museum of Natural History Dr. Elliot greatly aided the trustees by his wise scientific advice—at that time the only resident naturalist in New York equipped with the requisite experience and technical knowledge—and acted as their agent for several years in Europe in the pur-

chase of the important collections which formed the foundation of its present strong departments of mammalogy and ornithology. He has in later days shown his keen interest in its welfare through valuable gifts and appreciated advice.

On the occasion of his eightieth birthday, the American Museum made public recognition of his services through the publication of a brief biographical sketch of Dr. Elliot with portraits of him at the age of thirty years, at sixty-four (when curator of zoology at the Field Museum), and at eighty, and presented him with an engrossed memorial signed by the full scientific staff of the museum, giving him "greeting with grateful recognition and appreciation" of his services "as an expert adviser of the museum in its early days." A few months later he was elected to the board of trustees, from which his sudden removal by death is regarded as a great loss to the institution.

Dr. Elliot was not without further special honor in his home city. On March 24, 1914, the Linnæan Society of New York held a dinner in his honor in recognition of "his unique attainments in mammalogy and ornithology," at which the society presented him with its Linnæan medal of honor, the second occasion of the presentation of this medal. Dr. Elliot's speech of acceptance was in his characteristically graceful and happy vein. It was soon after published by the society as a special brochure.

Dr. Elliot was a man of striking personality, dignified and reserved in manner, conservative yet broadminded, constant and sympathetic in his personal friendships. His career was one of ceaseless activity in his lines of special research, and he has left many monuments to lighten the way of those who may follow in his footsteps. He fell into no ruts of routine that materially hampered his progress. On leaving England he was naturally deeply embued with the ways and methods of his British confrères, particularly in certain nomenclatorial matters, but these he was able to promptly abandon, accepting in their place the then radical innovations that had arisen in his home land during his absence. In other words, he soon accepted the A. O. U. Code of Nomenclature, with the date of Linné at 1758 instead of 1766, its trinomialism, and the point of view regarding species and subspecies thus entailed, which many of his colleagues of the earlier days of his sojourn abroad could never bring themselves to adopt.

Dr. Elliot was the fourth son of George T. and Rebecca Giraud Elliot. He was descended on his father's side from old Connecticut stock which settled near New London early in the sixteenth century, and on his mother's side from French ancestors who settled at New Rochelle and later moved to New York some two centuries ago. On the paternal side his forebears were prominent in public affairs, and in the colonial wars against the Indians. He was married in 1858 to Annie Eliza Henderson, by whom he had two daughters, of whom one, Margaret Henderson Elliot, still survives.

J. A. Allen
American Museum of Natural History,
New York

FRANCIS MARION WEBSTER

Science has suffered an irreparable loss and the entomological confraternity a severe shock in the death, by pneumonia, of Professor F. M. Webster, in charge of cereal and forage insect investigations in the U. S. Bureau of Entomology. The sad event occurred on January third at Columbus, Ohio, where he had gone in order to attend the meetings of the American Association for the Advancement of Science.

Francis Marion Webster was born at Lebanon, New Hampshire, August 8, 1849, and was therefore in his sixty-seventh year. His first entomological writing occurred in the *Chicago Weekly Interocean,* July 2, 1874, under the title of "Notes on Some of the Common Injurious Insects." He was appointed assistant state entomologist of Illinois in 1882 and served in that capacity until 1884, publishing several short but interesting and important papers on insects affecting cereal and forage crops. Professor Webster served

as special field agent to the U. S. Department of Agriculture from 1884 to 1892 and at other various times in his career. It was during the period mentioned above that he conducted the very important investigations on the buffalo gnats in Mississippi and Louisiana, resulting in the discovery of the conditions necessary for the maintenance of the larval existence of these pests, thereby paving the way for the institution of remedial measures eventually resulting in immense savings of money in the form of live stock, to say nothing of the assuagement of human misery.

In 1888 Professor Webster was detailed by the late Dr. C. V. Riley, then chief of the U. S. Division of Entomology, to visit Australia for the purpose of making a report on the agricultural features of the Melbourne International Exposition, the U. S. Exposition Commissioners making the preparation of this rereport conditional upon their agreement to assume the expense of the journey for both Professor Webster and another entomologist, Mr. Albert Koeble. The latter was charged with the work of collecting the natural insect enemies of the citrus fluted scale, which had accidentally become introduced into California, resulting in the discovery of the wonderfully efficient Coccinellid beetle, *Vedalia cardinalis*. Professor Webster visited portions of Australia, Tasmania and New Zealand, accomplishing his mission with eminent success and returning to this country in 1889.

During the years 1891 to 1902 he was entomologist to the Ohio State Experiment Station. This portion of his life was productive of much important biological research work and many valuable observations, not the least of which were his discoveries of the relations of ants to the existence of the corn root aphis, and those which resulted in his memorable paper on the Hessian fly, setting forth the now well substantiated theory to the effect that wheat should be planted subsequent to the emergence and death of the great bulk of adult flies in the autumn, resulting undoubtedly in the saving of vast sums of money to the progressive farmers of the entire wheat belt. During a portion of the years 1903–04 Professor Webster was connected with the Biological Survey of Illinois but his more important work was in the capacity of special field agent to the United States Department of Agriculture. The results of these investigations were made known in several bulletins of the old Division of Entomology. The most important of these is perhaps the paper entitled "Some Insects Attacking the Stems of Growing Wheat, Rye, Barley and Oats," regarded as a standard publication of its class for many years.

At the end of 1904 Professor Webster came to Washington to join the entomological service of the Department of Agriculture which had just been given bureau rank. The section of Cereal and Forage Insect Investigations was created in 1906 and Professor Webster placed in charge, which position he held at the time of his death. In this service the climax of his usefulness was attained. He started this work with a single assistant but under his masterly guidance its organization developed with giant strides until at the time of his death a staff of more than fifty trained entomologists were carrying out his plans and the section received from congress for the fiscal year 1915–16 an appropriation of $114,500. Professor Webster's life was a most industrious one. His hundreds of valuable papers dealing almost exclusively with the many phases of economic entomology will endure so long as the science of entomology itself.

Although recognizing fully the importance of taxonomic work in the field of biological science Professor Webster apparently never described a single genus or species, although he discovered many during his decades of biological research work. Several genera in hymenoptera and diptera have however been named in his honor by various authors. He evinced a tremendous interest in his work and was able through sheer force of character to transmit this quality to his entire staff of investigators, each one of whom was made to feel that his superior took a lively and intensely human interest not only in his work but also in him personally. The younger men will remember their lamented friend and chief

with especial gratitude for his kindly interest, generous viewpoint and sound advice. He evinced absolutely no trace of that petty jealousy regarding credits in the publication of results which mars the character of some otherwise truly big men in science. On the contrary, he was ever ready to sacrifice both time and labor in assisting his men in their efforts.

Professor Webster was a Fellow of the American Association for the Advancement of Science and the Indiana Academy of Science, and ex-president of the Association of Economic Entomologists, Ohio Academy of Science and the Entomological Society of Washington, a member of the Entomological Society of America, Biological Society of Washington, and the National Geographic Society. He was also an honorary member of the Entomological Society of Ontario and Corresponding member of the Cambridge Entomological Club and the New York Entomological Society. The degree of master of science was conferred on him by the University of Ohio in 1893.

Personally, Professor Webster was genial in manner, frugal and abstemious in habit and extremely simple in tastes; of exceeding honesty; in speech most temperate and he had acquired a literary style that was at once direct, lucid and forceful. He was also a most practical man, possessing a broad knowledge of agricultural methods and was therefore enabled to see his scientific problems from the viewpoint of the farmer. This latter faculty contributed as much perhaps as any one of his many excellent attributes toward the achievement of the magnificent success in economic entomology which was his.

Although Professor Webster's death occurred with shocking suddenness, he enjoyed a privilege granted to comparatively few men, in being permitted to spend nearly a half century in a labor he loved and to die at the very zenith of his usefulness and popularity in a manner which would very probably have been his choice, namely, "in the harness."

W. R. Walton

THE JOSEPH AUSTIN HOLMES MEMORIAL

A meeting was held in the Bureau of Mines, Washington, on January 15, 1916, at which the following were in attendance: Mr. Hennen Jennings and Mr. Van H. Manning, representing the American Institute of Mining Engineers; Dr. David T. Day and Dr. Joseph Hyde Pratt, the American Mining Congress; Mr. Samuel Gompers, the American Federation of Labor; Mr. William Green, the United Mine Workers of America; Dr. George Otis Smith, the Mining and Metallurgical Society; Gen. W. H. Bixby, the American Society of Mechanical Engineers; Mr. John H. Finney, the American Institute of Electrical Engineers; Dr. F. G. Cottrell, the American Electro-Chemical Society; Mr. George S. Rice, the National Safety Council; Dr. L. O. Howard, the American Association for the Advancement of Science; Dr. S. S. Voorhees, the American Chemical Society; Dr. Charles D. Walcott, Mr. Nelson H. Darton and Dr. Joseph Hyde Pratt, the Geological Society of America; Dr. David White, the National Academy of Sciences; Major Robert U. Patterson, the American Red Cross Society, and Mr. William L. Hall, the American Forestry Association.

The object of the meeting was to consider a permanent memorial to the late Dr. Joseph A. Holmes, the founder of the United States Bureau of Mines. After an extended discussion, the following resolutions were adopted:

Whereas, it is the sense of this meeting that a suitable memorial be established to honor the memory of the distinguished humanitarian and scientist, Dr. Joseph A. Holmes, therefore be it

Resolved, First, That each national body or society here represented and others that desire to be represented be requested to approve a permanent organization or incorporation to be known and named "The Joseph A. Holmes Safety First Association," and that each such national body or society shall appoint one representative to act with other representatives in such permanent organization.

Resolved, Second, That a meeting be held of the duly appointed representatives of the Bureau of Mines building, Washington, D. C., on March 4,

1916, at which a permanent organization is to be effected.

Resolved, Third, That pending the formation of a permanent organization the temporary officers continue together with two members to be appointed by the chair as an executive committee with authority to incur necessary expenses, and that the temporary officers be authorized and empowered to take all necessary action in furtherance of the purposes of the permanent organization.

Resolved, Fourth, That the proposed organization when so effected shall through its various members and organizations endeavor to collect sufficient funds to carry out the purposes of this association.

Resolved, Fifth, That each national body or society becoming a member of this organization shall select its representative and notify the temporary secretary of such membership and selection.

Resolved, Sixth, That the temporary organization commends to the permanent organization the annual award of one or more medals which, together with honorariums, shall be termed The Holmes Award for the encouragement of those originating, developing and installing the most efficient "safety first" devices, appliances or methods in the mineral industry and also special medals for the recognition of personal heroism or distinguished service in the mineral industry. However, further suggestions are invited from the organizations to be represented in this association.

SCIENTIFIC NOTES AND NEWS

PROFESSOR STEPHEN ALFRED FORBES, of the University of Illinois, and Professor Samuel Wendell Williston, of the University of Chicago, were elected honorary fellows of the Entomological Society of America at its meeting at Columbus, Ohio.

DR. P. A. LEVENE, member of the Rockefeller Institute for Medical Research and director of the chemical laboratories, has been elected an ordinary member of the Rega Societas Scientiarum Upsaliensis in recognition of his scientific activities.

THE Geological Society of London has made the following awards of medals and funds: Wollaston medal, Dr. A. P. Karpinsky (Petrograd); Murchison medal, Dr. R. Kidston, F.R.S. (Stirling); Lyell medal, Dr. C. W. Andrews, F.R.S. (Natural History Museum, London); Wollaston fund, Mr. W. B. Wright (Geological Survey of Ireland); Murchison fund, Mr. G. W. Tyrrell (Glasgow University); Lyell fund, Messrs. M. A. C. Hinton and A. S. Kennard.

THE faculty of Presidency College, Calcutta, has appointed Dr. J. C. Bose professor emeritus.

AMONG the members of the Assay Commission for the coming year, appointed by President Wilson, are Professor Jas. Lewis Howe, Washington and Lee University; Professor Andrew C. Lawson, University of California, and Dr. F. W. Clarke, U. S. Geological Survey. The commission will meet at the Philadelphia Mint February 9 to test the weight and fineness of the coins reserved by the several mints of the country during the past year.

A COMPLIMENTARY dinner was given to Professor Victor C. Vaughan, dean of the medical department of the University of Michigan, at the Harvard Club, New York City, by the faculty of the University and Bellevue Hospital Medical College, on January 12.

As has been already announced, Dr. John H. Wigmore, professor of law in Northwestern University, was elected president of the American Association of University Professors at the annual meeting. It is now announced that Professor H. W. Tylor, professor of mathematics at the Massachusetts Institute of Technology, has been elected to the secretaryship.

DR. W. H. PERKIN, F.R.S., professor of chemistry at the University of Oxford, has accepted the post of head of the research department of British Dyes, Limited. He has also accepted the chairmanship of the Advisory Council of that company, in the place made vacant by the death of the late Professor Raphael Meldola, F.R.S.

THE loss which the U. S. Geological Survey has suffered through the death of Mr. Sledge Tatum necessitates the following assignments in the topographic branch: William H. Herron to be acting chief geographer to serve for the balance of the fiscal year; Glenn S. Smith as topographic engineer in charge of the central division for the same period, and Claude

H. Birdseye as topographic engineer in charge of the Rocky Mountain Division. In case of the temporary absence of the branch chief the division chiefs will act for him with full authority, in the following order of seniority: Frank Sutton, T. G. Gerdine, G. R. Davis, C. H. Birdseye, G. S. Smith.

C. William Beebe, curator of birds of the New York Zoological Society, has sailed for British Guiana to establish a tropical zoological station. Mr. Beebe will build a bungalow on the edge of the jungle and there he will study the habits of birds in their own province. A complete laboratory outfit will be taken. With him will be Inness Hartley, who goes as research associate; Paul Holmes, whose interest is in photography and work with insects, and Mr. Carter, who goes as collector.

Professor Charles H. Tuck, of the college of agriculture, Cornell University, has left Ithaca on a sabbatic leave of absence which will extend to next September. He is on his way to Manchuria, where he is to make agricultural investigations.

Professor S. Nawaschin, for many years professor of botany in the University of Kiew, Russia, and also director of the botanical garden of that place, has gone to Tiflis. He wishes his botanical correspondents to note that his address is now Botanic Garden, Tiflis (Caucas), Russia.

The Frederick Forchheimer chair of medicine in the University of Cincinnati was formally inaugurated on January 28. President Charles W. Dabney made an address on Frederick Forchheimer and scientific methods; Dr. Christian R. Holmes, dean of the college of medicine, spoke on the history of the founding of the chair, and Dr. Roger S. Morris, recently appointed to the chair, also made an address.

Professor Lafayette B. Mendel, of Yale University, will give a course of three lectures at the University of Illinois on the subject of "Some Features of Growth," February 10, 11 and 12. He will also be a speaker at an assembly of the College of Agriculture, when he will speak on the topic, "Changes in the Food Supply and Their Relation to Nutrition."

Before the New York Electrical Society on January 27, Professor Michael I. Pupin, of Columbia University, gave an address on "Wireless Transmission Problems."

The Lettsomian lectures before the Medical Society of London will be delivered by Major F. W. Mott, F.R.S., on February 7 and 21 and March 6, the subject selected being the effects of high explosives on the central nervous system.

The late Professor Meldola bequeathed his entomological collection and cabinets to the Hope Museum, Oxford. If there are no grandchildren £500 each is to be paid to the Royal Society, the Chemical Society, the Entomological Society and the Institute of Chemistry of Great Britain and Ireland.

A gift of $2,000 has been made to Cornell University by Professor Simon H. Gage and his son, Henry Phelps Gage, to provide for the construction of a room in a new dormitory for women students. The gift is made as a memorial to Susanna Phelps Gage (Mrs. Simon H. Gage), author of valuable contributions to embryology and comparative anatomy.

The Medical Society of the District of Columbia and the Association for the Prevention of Tuberculosis of the District held a joint meeting on January 19, in memory of the late Surgeon-General George M. Sternberg, U. S. Army. Addresses were delivered by Drs. George M. Kober, William C. Gwynn and Harvey W. Wiley.

Mr. Sledge Tatum died on January 18 after a long service with the Geological Survey. He was a topographer from 1899 to 1904. He then served on the Isthmian Canal Commission for four years, when he returned to the Geological Survey as topographic engineer and was appointed geographer of the Rocky Mountain Division in 1910. A short time prior to his death he was appointed acting chief geographer. Mr. Tatum's services to the government have been of a high order. He had ability and enthusiasm for his work and a personality which enabled him to secure loyal and efficient service from his associates.

THE death is reported of Mr. T. L. Wilson, of Ottawa, Canada, known for his inventions concerned with acetylene gas and carbide.

SIR CLEMENTS MARKHAM, who took part in the Arctic expedition of 1850 in search of Sir John Franklin, and subsequently engaged in many geographical explorations, president of the Royal Geographical Society from 1893 to 1905, died on January 30, at the age of eighty-six years.

SIR FRANCIS HENRY LOVELL, dean of the London School of Tropical Medicine, died on January 28 in London. Sir Francis had been chief medical officer of Mauritius and a member of the legislative council and he had served as surgeon-general and as a member of the executive and legislative councils of the colonies of Trinidad and Tobago.

SIR H. EVELYN OAKELEY, author of mathematical works and reports on educational subjects, has died, aged eighty-two years.

GRAF ZU SOLMS-LAUBACH, who held the chair of botany first at Göttingen and afterwards at Strasburg, has died at the age of seventy-two years.

GUIDO BACCELLI, professor of clinical medicine at the University of Rome and chief of the general hospital, the Policlinico, the erection of which was mostly his work, has died, aged eighty-four years.

THE New York Academy of Sciences will celebrate in May, 1917, the centenary of its foundation. The president has been authorized by the council of the academy to appoint five committees in charge of exhibition, meetings, funds, history and membership.

AT the close of the Nineteenth International Congress of Americanists, held in Washington, December 27–31, 1915, a formal invitation was accepted from Brazil to hold the next American Congress at Rio de Janeiro in June of 1918. The invitation was extended through Dr. A. C. Simoens da Silva, by the National Museum, National Library, National Archive, the Brazilian Historical and Geographical Institute and the Society of Geography, at Rio de Janeiro, and the Historical and Geographical Institute Fluminense.

AT the tenth annual meeting of the Entomological Society of America, held at Columbus, Ohio, December 29 and 30, the following officers were elected: *President,* F. M. Webster, U. S. Bureau of Entomology; *First Vice-president,* E. P. Felt, New York State Entomologist; *Second Vice-president,* A. L. Melander, Washington State College; *Secretary-Treasurer,* J. M. Aldrich, U. S. Bureau of Entomology, West LaFayette, Indiana; *Additional Members of the Executive Committee,* H. T. Fernald, Massachusetts Agricultural College; W. E. Britton, state entomologist of Connecticut; P. J. Parrott, entomologist, New York Agricultural Experiment Station; E. D. Ball, Oregon Agricultural College; C. Gordon Hewitt, Dominion entomologist.

THE Florida Entomological Society has recently been organized at Gainesville, Florida, with fifteen charter members. The first officers elected were Professor J. R. Watson, entomologist of the Florida Experiment Station, *President;* Mr. Wilmon Newell, plant commissioner of Florida Plant Board, *Vice-president,* and Mr. R. N. Wilson, U. S. Bureau of Entomology, *Secretary-Treasurer.* A paper was read on the Velvet Bean Caterpillar (*Anticarsia gemmatilis*), by Professor Watson, and another by Dr. E. W. Berger, entomologist of the Florida Plant Board, on the fungus diseases of scales and white flies on citrus.

AT the annual meeting of the Brooklyn Entomological Society, held on the thirteenth inst., the following officers were elected for 1916: *President,* W. J. Davis; *Vice-president,* W. T. Bather; *Treasurer,* Chris. E. Olsen; *Recording Secretary,* J. R. de la Torre Bueno; *Corresponding Secretary,* R. P. Dow; *Librarian,* A. C. Weeks; *Curator,* Geo. Frank; *Publication Committee,* C. Schaeffer, R. P. Dow and the recording secretary, *ex-officio.*

WHILE the aniline dye, potash and other chemical industries have attracted a great deal of attention since the beginning of the European war, little has been heard about the great impetus the war has given our electrochemical industries. Many electrochemical products such as chlorine and hydrogen, which were a

drug on the market before the war, have become valuable. New electrochemical industries, like that of metallic magnesium, have been started and the whole electrochemical development is of the utmost importance to the American nation. The New York Section of the American Electrochemical Society has therefore arranged a symposium on "Electrochemical War Supplies" which it will hold jointly with the New York sections of the American Chemical Society and the Society of Chemical Industry at the Chemist's Club, 52 East 41st St., New York, Friday evening, February 11. The program will include the following papers:

Lawrence Addicks: "Electrochemical War Supplies."
W. S. Landis: "Air Saltpeter."
E. D. Ardery (U. S. Army): "Hydrogen for Military Purposes."
Albert H. Hooker: "New War Products."
William M. Grosvenor: "Magnesium."
G. Ornstein: "Liquid Chlorine."
Geo. W. Sargent: "Electric Steel."

On December 13, there was installed at the University of Pittsburgh, the Beta chapter of the Sigma Gamma Epsilon, the charter members of the new chapter consisting of Dean H. B. Meller, dean of the school of mines, Professor H. C. Ray, professor of metallurgy, and sixteen undergraduates. The Sigma Gamma Epsilon fraternity was founded at the University of Kansas during the past year, and its membership is confined to teachers of geology, mining, or metallurgy, and students who are specializing in those subjects.

The executive committee of the Association of American Universities held a meeting at the University of Pennsylvania on January 24. There were present the following representatives of five universities: Dr. Thomas McBride, president of the State University of Iowa, the president of the association; President Frank J. Goodnow, of Johns Hopkins University, vice-president of the association; President William A. Bryan, of Indiana University; President A. Ross Hill, of the University of Missouri. The University of Pennsylvania was represented by Provost Edgar F. Smith and Dean Herman V. Ames, the University of Pennsylvania, being secretary of the association. The chief business before the committee was to arrange the next annual meeting of the association, which it was voted should be held next fall at Clark University, Worcester, Mass. The following topics were selected for discussion at that time: "How Can Universities be Organized so as to Stimulate work for the Advancement of Science"; "Military Training in Universities and Colleges"; "The Correlation of Work for Higher Degrees in the Graduate School and in Professional Schools."

For ten weeks during the summer of 1916 a party of students and professors from the department of forestry of the New York State College of Agriculture at Cornell University will be in camp on the forest tract belonging to Mr. T. C. Luther at the south end of Saratoga Lake. Last year the Cornell forestry department was in camp on a forest tract in the Northern Adirondacks, on which an estimate of the standing timber was made and a general plan for management was drawn up. A similar study will be made on Mr. Luther's tract, except that in 1916, owing to the proximity of this tract to numerous wood-using mills, greater attention can be paid to the problems of forest utilization.

UNIVERSITY AND EDUCATIONAL NEWS

A "Plan for the Development of the University of California Medical School" has been formally adopted by the regents of the University of California, as a policy to be worked toward. The University of California has now increased to a total of $162,221 per annum its expenditures on medical instruction, over and above the hospital receipts, and within the next few months it will complete the erection, at a cost of $615,000, of a new 216-bed teaching hospital. The regents have now outlined as the immediate future needs of the medical school, a new laboratory building for anatomy and pathology, to cost $150,000; an "out-patient" building in conjunction with the new teaching hospital, to cost $100,-

000; a nurses' home for 100 nurses, to cost $100,000; and alterations of the existing buildings on the Parnassus Avenue site in San Francisco to accommodate the departments of physiology and physiological chemistry, administrative offices and the medical library.

EDWARD PLAUT, of the class of 1912, has presented $5,000 to Princeton University to establish the Albert Plaut Memorial Library of Chemistry, in memory of his father.

MR. CHRISTOPHER WELCH has left his real estate in the county of Somerset to the University of Oxford for the endowment of scholarships for the study of biology, to be known as the "Welch" scholarships. They are to be tenable for four years and their value is to be £400 a year, any surplus income to be paid into a reserve fund formed by the residue of his estate, to be used for the upkeep of the estate and for furthering the study of biology. If the university does not accept the conditions attached to the bequests then the amount goes to six London hospitals, one of which shall be St. George's Hospital; but no hospital where vivisection is disallowed or discountenanced is to benefit, "antivisectionists being enemies of the human race."

SIR ALEXANDER M'ROBERT has given to Aberdeen University an endowment of about £750 per annum for a Georgina M'Robert lectureship on pathology, with special reference to malignant diseases. The donor recently gave an endowment of £373 per annum to the Aberdeen Royal Infirmary. He is director of the Cawnpore Woollen Mills Company, but before going to India thirty years ago he was Neil Arnott lecturer in experimental physics at the Aberdeen Mechanics' Institution and lecturer in chemistry at Robert Gordon's College, Aberdeen.

THE one hundred and fiftieth anniversary of the founding of the medical school by John Morgan at the University of Pennsylvania will be celebrated by a dinner to be given by the Society of the Alumni of the Medical School at the Bellevue Stratford on the evening of February 4. The committee expects to make this event the largest gathering of its kind ever held by the medical alumni, since it also marks the celebration of the beginning of medical teaching in the United States.

MR. R. M. RAYMOND, managing director of the El Oro Company, has been appointed professor of mining in the School of Mines of Columbia University, succeeding Professor Henry S. Munroe, who retired last June after twenty-seven years of service.

DR. CLARENCE W. FARRAR, of the State Hospital for the Insane, Trenton, has been appointed lecturer on abnormal psychology in Princeton University.

DISCUSSION AND CORRESPONDENCE

FIREFLIES FLASHING IN UNISON

FIFTY years ago in Gorham, Maine, while walking along the road I passed an open field and noticed to my astonishment hundreds of fireflies flashing in perfect unison. I watched this curious sight for some time and the synchronism of the flashing was unbroken. Many times after I have watched these luminous insects, hoping to see a repetition of this phenomenon, but the flashes in every instance were intermittent. Since that time I have read about these insects in various books without meeting any allusion to this peculiar behavior. At last I have found a confirmation of my early observations. In *Nature* of December 9, page 414, is the report of an interesting paper read before the South London Entomological and Natural History Society by K. G. Blair entitled "Luminous Insects" in which reference is made to the remarkable synchronism of the flashes in certain European species of fireflies. The explanation offered as to the cause of this behavior seemed to me inadequate. One often notices in the stridulation of the Grillidæ the perfect time the insects keep in their concerts and it seems likely that the same impulse must animate these flashing beetles, and the light emitted could be more easily followed than the sound.

The following is an extract from Mr. Blair's paper:

> Apart from its principal function in securing the proper mating of the sexes, the light seems

also to be largely used, at any rate by the males, for purposes of display. Where the powers of luminosity are largely developed in this sex the emission of the light is usually of an intermittent flashing type. It has been noticed in various parts of the world that these flashing males tend to congregate in large companies, and that all the individuals of one of these gatherings will flash in concert. All the fireflies around one tree or group of trees, for instance, will flash together, while those around a neighboring tree will be pulsating to a different time. This feature has been observed of a European species of *Luciola* (though Mr. Main and myself were unable to detect anything of the sort with *L. italica* at Lugano), of an Indian lampyrid genus not stated, and of the genus *Aspidosoma* in South America. The American species of *Photinus* and *Photuris* do not seem to possess the habit.

The exact reason of this flashing in concert, or the method by which it is brought about, have not been ascertained. It has been suggested that the light is not really intermittent in character, but merely appears so owing to its being alternately masked and exhibited by movements of the creature's body, and that a slight puff of wind might perhaps affect all the members of a company and cause them all to conceal their lights at once. Though this explanation of the intermittent character of the light applies well enough to *Pyrophorus*, an insect we shall shortly consider, it is certainly not applicable to these Lampyridæ. It is true the light is not absolutely extinguished between the flashes, but it is so diminished as to become practically dark; moreover the flashing in unison is too regular to be caused by chance puffs of wind. A more probable explanation of the phenomenon is that each flash exhausts the battery, as it were, and a period of recuperation is required before another flash can be emitted. It is then conceivable that the flash of a leader might act as a stimulus to the discharge of their flashes by the other members of the group, and so bring about the flashing concert by the whole company.

Edward S. Morse

POLYRADIATE CESTODES

In the last number of the *Journal of Parasitology*, Vol. 2, No. 1, p. 7, W. D. Foster, of the Bureau of Animal Industry, U. S. Department of Agriculture, gives an interesting summary of the cases of polyradiate cestodes and describes an adult triradiate cestode of the species *Tænia pisiformis* "found in a mass of tapeworms expelled by an imported collie dog." He states that "no case of an adult triradiate cestode of this species has yet been published." It is to be regretted that Foster did not investigate more thoroughly the literature on the polyradiate cestodes before publishing his article.

In Science, 1910, N. S., Vol. 31, p. 837, in an article "Some New Cases of Trihedral Tænia," we published a brief description of two new species of polyradiate cestodes based on the study of four perfect and entire specimens of *Tænia serrata* = *Tænia pisiformis* and three perfect specimens of *Tænia serialis* which were secured from four dogs picked up on the streets of Lincoln.

Foster bases his description on a "number of chains of triradiate proglottids, the longest piece being 23 cm. representing the anterior half of the worm, except the head." From the study of our specimens we question the validity of a specific diagnosis of *Tænia pisiformis* from proglottids alone, without verification from the scolex.

He states that "the identification of the species was verified by feeding experiments on a rabbit" and that "although shipped in a solution of formalin of unknown strength, and kept in a 2 per cent. solution of formalin for one week after it was received, it was determined to use some of the material for feeding experiments." Foster states that he recovered seven "perfectly normal larvæ" of *Tænia pisiformis* from the omentum and body cavity of a rabbit reared and kept in captivity, thirteen months after feeding with two of the proglottids of the triradiate *Tænia pisiformis* which had been preserved and kept in formalin. It seems to us that the reliability of the results of these feeding experiments is open to serious question, first in the use of material preserved in formalin of uncertain strength and kept in a 2 per cent. solution for one week after it was received and second in the uncertainty as to the previous natural infection of the rabbit used, for we have repeatedly found our rabbits, born and reared in captivity, heavily infected with *Cysticercus pisiformis*.

Foster failed to read and consequently does not cite along with the other theories advanced as to the origin of the polyradiate cestodes, the theory offered by us in the article previously cited, namely that the polyradiate cestodes do not represent distinct species or genera which necessarily originate from and in turn give rise to onchospheres with supernumerary hooks and cysticerci with an excessive number of suckers but may arise from double embryos produced by the partial *separation* of early blastomeres and not by the *fusion* of normal embryos.

In the light of a large amount of data both in the case of natural and experimentally produced twin embryos and adults of a large number of animals which shows that the individuals may be joined in various ways and degrees, our theory as to the origin of the polyradiate cestodes seems the most logical of those offered.

FRANKLIN D. BARKER
THE UNIVERSITY OF NEBRASKA

AN ORGANIC OOLITE FROM THE ORDOVICIAN

MICROSCOPIC examination of a siliceous oolite from the so-called transition bed between the Prairie du Chien dolomite and St. Croix sandstone at McGregor, Iowa, shows the oolite grains to possess undoubted organic structures of the algal type. The matrix of the oolite grains is dolomitic, and many of the original grains themselves have been partly or wholly changed to dolomite with obliteration of structure, prior to silification.

The grains range from .1 mm. to 1.13 mm. in diameter, and, when well preserved, show good concentric and radial structure in addition to the minute sinuous fibers similar to those which characterize the *Girvanella* type of calcareous algæ. These fibers have an average diameter of about .015 mm. Typically the well-preserved grains consist of an inner structureless nucleus, followed by an intermediate band showing radial structure, and this again by an outer band bearing the sinuous fibers. In some instances, however, the two outer bands grade gradually into each other without any distinct line of demarcation.

In view of the present controversy regarding the origin of oolite, it is believed that this occurrence merits more than passing notice.

FRANCIS M. VAN TUYL
UNIVERSITY OF ILLINOIS

USE OF C.G.S. UNITS

IN SCIENCE of December 24, page 904, Professor Kent has been good enough to review the various points raised in the discussion concerning the fundamental equation of dynamics. As space is limited and the discussion has been prolonged, the pedagogic difficulty in the definition of the dyne may be passed over for the present. Whether there is real difficulty in expressing certain derived units because of the use of exponents is open to argument. The cent is a serviceable unit notwithstanding that some financial transactions run up to the millions.

Of more importance however is Professor Kent's statement:

> Of course it is not difficult for *one* who is engaged constantly in the use of the C.G.S. system and who during that year has had no occasion to use the old units, to break away from them, but it is not only difficult but impossible, for a hundred million people who are constantly using the old units to break away from them.

Has he not here overlooked the fact that of the three fundamental units, centimeter, gram and second, one at least, the unit of time, *is* constantly used by more than a hundred million people; and of the three concepts, it is perhaps the most difficult. Are not most scientific men to-day in all countries using C.G.S. units and their derivatives? Is not the kilometer more widely used than the mile; and has not the kilogram come into very general use?

ALEXANDER MCADIE

THE FIRST SECRETARY OF AGRICULTURE

TO THE EDITOR OF SCIENCE: I wish to correct a misstatement which occurred in my article on "Botany in Relation to American Agriculture," published in SCIENCE, January 7. In this article I stated that J. M. Rusk was the

first secretary of agriculture in the President's cabinet. I based this statement upon the fact that the yearbook of the Department of Agriculture for 1888 contained the last report of N. J. Colman as commissioner of agriculture, and the yearbook of 1889, the first report of J. M. Rusk as secretary of agriculture. In his report Rusk states:

> I have the honor to respectfully submit my first annual report as secretary of agriculture, and the first report issued under the newly constituted Department of Agriculture. I assumed the duties of my office March 7, 1889, or twenty-six days after the approval of the law creating an executive department of what had heretofore been a bureau, in executive sense, of the government.

As no mention was made in either report of Colman having acted as secretary of agriculture during this short interval, I took it for granted that Rusk was the first secretary. I have received a letter from Dr. L. O. Howard, however, in which he states that Colman was really the first secretary of agriculture. He writes:

> Mr. Colman was commissioner of agriculture when the bill passed, and was appointed first secretary by President Cleveland on February 13, 1889, his services terminating with the outgoing of the administration on March 6, 1889.

G. P. Clinton

SCIENTIFIC BOOKS

Quantitative Laws in Biological Chemistry. By Svante Arrhenius. London, G. Bell and Sons, Ltd. 160 pp. 6 s. net.

The present volume is a restatement of the grounds upon which the illustrious author of the electrolytic dissociation theory arrived at the conviction that "biological chemistry can not develop into a real science without the aid of the exact methods offered by physical chemistry." It comprises a short résumé, developed with a remarkable degree of clarity and simplicity, of the author's work in the quantitative field of bio-chemistry, together with the investigations of others on neighboring ground. Originally, the material was compiled for the Tyndall lectures given in the Royal Institution in 1914, and is now offered to the public in the hope that it will evoke interest for the new discipline and stimulate new work.

A perusal of the volume, which deals mainly with the velocity of biochemical reactions, the influence of the several factors which govern such velocities and the position of equilibrium can not fail to impress the reader with certain facts. The fundamental import of a knowledge of physical, or rather theoretical, chemistry to the medical student of the future is readily grasped from these pages. The descriptive side of chemical science will more and more be found to be inadequate as a training for the complicated phenomena which the medical student will subsequently face. The volume shows that a real comprehension of the notions of experimental error, probable error and the like will open up to the student new and immense fields for research and for advance.

What is the chief task in that advance? It is to see how far the physico-chemical laws regarding the process of chemical reaction are applicable to biochemical processes and, what is much more important, to attempt to elucidate such processes as have been considered exceptions from known chemical laws. The yield which such an attempt will give is amply illustrated in the present work. It is hard to conceive an ungenerous attitude to a method which has elucidated so many organic processes. The well-known rule of Schutz is a case in point. It is shown that the deviation from the common monomolecular law is readily explainable on the basis of the influence of one of the reaction products on the course of the reaction. Further, the general law for such phenomena is as readily obtained and can be experimentally verified. The more complex phenomena of digestion, secretion and resorption in an animal's body may be shown, as the researches of Pawlow and his co-workers have established, to consist of a number of very simple regularities operating "in vivo" just as "in vitro" and extraordinarily independent of psychical effects and other factors which might lead to the belief that a quantitative study of such phenomena was impossible. As regards chemical equilibria mani-

fested in biochemical processes one can not refrain from contrasting, with Arrhenius, the explanation of the Ehrlich phenomenon on the basis of the law of mass action and that based on the assumption of multitudinous "partial poisons," toxins and toxoids, forming a characteristic if somewhat unintelligible "poison spectrum."

The book should operate as a stimulus and a spur. From personal contact the writer has reaped no small benefit and much inspiration in other branches of the scientific field. Could this volume attract the attention of some young student in the field of biochemical labors and induce in him the determination to go to the source and obtain personally the fruits of ripened thought and mature judgment progress would surely result. In the present pages there is manifest the characteristic genius of the author with his clarity of presentation of the particular thesis in hand. A few infelicities of English occasionally mar the text and suggest that perhaps the assistance of the English editor might have been a little more generously given. Words such as "inanimated" and "stomachical" might readily have been replaced.

HUGH S. TAYLOR

PRINCETON, N. J.

The Physiology of the Amino Acids. By FRANK P. UNDERHILL, Ph.D. Yale University Press. 1915. Pp. 169. Price $1.35.

It is truly symptomatic of modern scientific development that books should be written which divide physiology into physical and chemical portions, and that following this classification still finer divisions are introduced. One of these latter subdivisions is treated for the first time as an entity in Underhill's delightful little book, "The Physiology of the Amino Acids." Each known amino acid is enumerated and its discoverer given. Then follow those details which have thus far been unravelled regarding the intimate life history within the organism of the behavior of the structural units which compose the protein molecule. From the descriptions given in this book the reader may readily grasp the processes of synthesis and analysis, of oxidation and of reduction through the interplay of which protein under given conditions may be resolved into carbonic acid and urea, and under other conditions, into the texture of the living cells. For emphasis of the latter destiny Osborne and Mendel's experiments on the growth of rats form a fitting descriptive material. The book will be of interest and value to biologists in general and to physicians who have not forgotten their chemistry.

GRAHAM LUSK

SPECIAL ARTICLES

THE DISCOVERY OF THE CHESTNUT-BLIGHT PARASITE (ENDOTHIA PARASITICA) AND OTHER CHESTNUT FUNGI IN JAPAN

To Mr. Frank N. Meyer, agricultural explorer of the office of foreign seed and plant introduction of the Department of Agriculture, belongs the distinction of having discovered the chestnut-blight fungus (*Endothia parasitica*) in Japan as well as in China.[1, 2]

Meyer's discovery of the fungus in China has been accepted as proof of the oriental origin of this parasite which has proven so destructive to the chestnut in the northeastern United States and is rapidly spreading southward. Its discovery in Japan furnishes additional evidence as to the correctness of Metcalf's[3] hypothesis that the parasite was introduced into this country from Japan.

Meyer's discovery of *Endothia parasitica* in China made the presence of the same fungus in Japan seem extremely probable. And later, during her visit to this country in the fall of 1914, Dr. Johanna Westerdijk informed the writers that while in Japan she had seen at

[1] Fairchild, David, "The Discovery of the Chestnut-bark Disease in China," SCIENCE, N. S., Vol. 38, No. 974, pp. 297–299, August 29, 1913.

[2] Shear, C. L., and Stevens, Neil E., "The Chestnut-blight Parasite (*Endothia parasitica*) from China," SCIENCE, N. S., Vol. 38, No. 974, pp. 295–297, August 29, 1913.

[3] Metcalf, Haven, "The Immunity of the Japanese Chestnut to the Bark Disease," Bur. Plant Ind., U. S. Dept. Agr. Bull. 121, Pt. 6, 1908.

Nikko and other places chestnut trees affected by a fungus which appeared identical with *Endothia parasitica* in this country. Miss Westerdijk also stated that she had collected specimens of the fungus but these specimens with many of her other collections were lost at sea.

Following this the writers endeavored to obtain specimens of the chestnut-blight parasite by correspondence. Among those to whom the request was sent was Mr. H. Loomis, of Yokohama, who very kindly interested himself in the matter, and on February 18 wrote as follows:

> In compliance with your request of January 4 I have communicated with Professor Y. Kozai, of the Imperial Agricultural Station, Nishigahara, Tokyo, and he writes that "The chestnut blight is found to some extent in the Provinces of Tamba, Ise, Suruga and Shimotsuke (Nikko is in the latter). This disease is limited to the seedlings in the nursery and the young trees (three or four years old) in the field and may be prevented by spraying with Bordeaux mixture."
>
> I have requested him to procure specimens of the fungus and send the same to you directly. I hope this will meet your desire. . . .

Soon after this a packet of three specimens of fungi on chestnut bark was received from Professor Y. Kozai with a letter stating that they were "specimens of the Japanese chestnut canker." None of these proved to be *Endothia parasitica,* but one specimen collected October 14, 1915, in the province of Totomi by S. Tsuruta, and labeled "Cancer on chestnut," was evidently an *Endothia,* which after careful study of stromata, pycnospores and cultures on various media the writers are convinced is identical with the oval-spored species of *Endothia* found both in this country and in Europe and referred to in their earlier paper[4] as *Endothia radicalis* (Schw.) De Not. The other two specimens sent by Professor Kozai showed no *Endothia* but two other Pyrenomycetes.

[4] Shear, C. L., and Stevens, Neil E., "Cultural Characters of the Chestnut-blight Fungus and Its Near Relatives," Circ. No. 131, B. P. I., Dept. Agr., July 5, 1913.

Shortly before the specimens above referred to were received from Japan a number of specimens of Japanese chestnut from California were turned over to the writers for study. These were part of a shipment from the Yokohama Nursery Co., Yokohama, Japan, consigned to the Sunset Nursery, Oakland, Cal., which were condemned in February, 1915, by Frederick Maskew, chief deputy quarantine officer, San Francisco, Cal., upon recommendation of Dr. E. P. Meinecke, forest pathologist, U. S. Department of Agriculture, stationed in that city. In his letter recommending the destruction of this nursery stock Dr. Meinecke called attention to the presence of a fungus apparently parasitic which "in the absence of other fruiting forms must be classed with the fungi imperfecti (*Cytospora* species.)" Of 100 plants examined Dr. Meinecke found 43 infected with this fungus. A number of the infected trees were turned over to the writers by the Federal Horticultural Board and bear their plant disease survey number 264.

The writers have had the fungus referred to by Dr. Meinecke in culture since early in April, 1915, and have made inoculations on the native American chestnut (*Castanea dentata*) but thus far have been unable to obtain ascospores or any evidence of parasitism on *Castanea dentata.*

In addition to this fungus two of the Japanese seedlings received from California showed a few tiny, yellow ochre pycnidial stromata, smaller than but closely resembling in form and color those of *Endothia radicalis.* A careful study of the pycnidia, pycnospores and cultures of this fungus on various media has convinced the writers that this also is a species of *Endothia* having quite different cultural characters from any species yet known.

Mr. Walter T. Swingle during his recent visit to Japan obtained a small portion of a specimen which was exhibited as chestnut-blight. This specimen which was given him by Dr. Nishida is not an *Endothia,* but so far as can be determined from cultures appears to be identical with the imperfect fungus found on the Japanese chestnuts condemned at San Francisco in February, 1915.

From a study of these few specimens it is evident that there are in Japan several Pyrenomycetes including species of *Endothia* more or less parasitic on chestnut. This fact may help to explain the failure of Japanese pathologists to distinguish the true chestnut blight caused by *Endothia parasitica*. Dr. Gentaro Yamada on his recent visit, July, 1915, to this country, informed the writers that the numerous publications concerning the chestnut-blight in the United States had naturally aroused the interests of Japanese pathologists but that so far they had been unable to find any parasitic *Endothia*. This is further verified by a paper in Japanese[5] by Kanesuke Hara, an abstract of which has been kindly furnished us by Dr. T. Tanaka. Hara considers that *Endothia gyrosa* (Schw.) Fuck. must be identical with *E. parasitica* (Murr.) A. & A. He describes a species of *Endothia* found on a dead twig of *Quercus glandulifera* Bl., which he regards as *Endothia gyrosa*. This report indicates that species of *Endothia* occur in Japan upon *Quercus* as well as on *Castanea*. We have just received pycnidia of an *Endothia* on chestnut from Mt. Hara labelled *E. gyroza?* which in culture appears different from any species yet cultured by the writers.

Having failed to obtain a specimen of *Endothia parasitica* by correspondence and learning that Mr. Meyer was to visit Japan on his return from China, the writers requested Mr. David Fairchild, agricultural explorer in charge of foreign seed and plant introduction, to send a cablegram asking him to look for the chestnut blight in the vicinity of Nikko. Meyer's observations in Japan are best given by quotations from his letters:

Sept. 17. Frid. In Nikko . . . found plenty of evidences of the chestnut-blight, especially on the higher, more exposed parts of the mountains; collected a large bundle of material, took several fotos. . . .[6]

Sund. Sept. 19. In Yokohama; . . . inspected grafted and budded nursery stock, especially chestnuts and cherries, found them exceptionally clean. No signs of *Diaporthe parasitica* on chestnut seedling and grafted stock, although the wild trees of *Castanea japonica* on the hills surrounding the nurseries are infested with the blight.

Mond. Sept. 20. In Yokohama; . . . The chestnut-blight, *Diaporthe parasitica*, is quite common in Japan, that is at least around Nikko, Tokyo and Yokohama. Wild as well as cultivated trees are attacked, though the disease, as a whole, is not very destructive. Trees vary considerably as regards powers of resistancy and on the lower slopes of hills around the Kanaya Hotel at Nikko, trees were found that were large and vigorous and apparently immune, while on the higher mountains and more exposed parts trees were found that were badly attacked. This Japanese chestnut, *Castanea japonica* might be used as a factor in hybridization experiments, together with American, European and Chinese species to create immune or nearly immune strains of chestnuts.

Meyer further states to the writers that the Japanese chestnut, *Castanea crenata* Sieb. & Zucc., is even more resistant to *Endothia parasitica* than is the Chinese chestnut, *Castanea mollissima*. This further emphasizes the difficulty of locating *E. parasitica* on chestnut in Japan where as already stated several other fungi are common.

On the arrival of Meyer in Washington he gave the writers specimens of diseased chestnut branches collected at Yokohama and at Nikko. On the material from Yokohama no *Endothia* was found. Specimens from Nikko which were more abundant showed cankers and mycelial fans typical of *Endothia parasitica* and numerous stromata of the fungus. Some of these stromata contained mature ascospores and many of them viable pycnospores and ascospores. Cultures were at once made on cornmeal in flasks and on cornmeal and potato agar. These cultures proved identical with cultures made at the same time from typical *E. parasitica* collected in this country and also with the Chinese material which has been kept in pure culture. While the season of the year makes inoculations impossible the mycelial and spore characters of this fungus

[5] Hara, Kanesuke, "Further Discussion Must be Needed on the Problem of the Chestnut-blight Disease, 'Byôchû-gai Zassi'" (*Journal of Plant Protection*), Vol. 2, No. 3, March, 1915, pp. 242–245 (Japanese).

[6] Some of the pictures of blighted chestnuts taken by Meyer at Nikko will be published later.

as well as its cultural characters are so distinctive as to leave no doubt as to its identity. The fungus collected by Meyer at Nikko is unquestionably *Endothia parasitica*.

The above statement was completed and submitted for publication December 23, 1915. During the interval following, several specimens of fungi from Japan have been received by the writers which are of such interest in connection with the observations recorded above that it seems desirable to add them. On December 27, 1915, there was received from the Federal Horticultural Board a specimen of diseased chestnut nursery stock (their number 947), which had been sent by H. M. Williamson, secretary of the State Board of Horticulture at Portland, Oregon.

In the letter transmitting the specimen Mr. Williamson states that it was from

> an importation of nursery stock . . . grown at Kanagawa-Ken, Yokohama, Japan. . . . Included in this shipment were some chestnut trees and five of the chestnut trees were diseased. . . . Four of the chestnut trees have been burned and I am mailing you the other diseased tree under separate cover.

The fungus, which showed only pycnidia, has been cultured and is apparently the same as that found on the chestnut seedlings condemned at San Francisco in February, 1915, and mentioned above, and which was also found on the specimen brought from Japan by Swingle.

A small specimen of an *Endothia* collected at Nikko, Japan, September 17, 1915, on bark of *Pasania* sp. (*Quercus* of some authors), has been recently transmitted to the writers by Mr. Frank N. Meyer. This specimen shows typical ascospores of *Endothia radicalis* (Schw.) and in cultures proved identical with those of *Endothia radicalis* collected in this country. This collection seems to leave no doubt that *E. radicalis* is indigenous in Japan and that there as in Europe and America it is not confined to *Castanea*.

January 8, 1916, the writers received from Dr. Gentaro Yamada, of the Morioka Imperial College of Agriculture and Forestry, two specimens, one labeled "on *Quercus crispula*. Mt. Moriva, near Sapporo, Hokkaido, Japan. March 27, 1897. Coll. G. Yamada & T. Totsu," the other labeled "*Endothia parasitica* on *Castanea vulgaris* Lam. var. japonica DC. Morioka, northern Japan. Dec. 5, 1915. Coll. G. Yamada." The fungus on *Quercus crispula* was of course no longer viable. It contained, however, abundant ascospores which agree in their measurements with those of *Endothia radicalis*.

The specimen on *Castanea* is typical *Endothia parasitica*, as shown by the mycelial fans, pycnospores and ascospores, and by cultures. This specimen shows hypertrophy of the tissues very similar to that produced by the fungus on American chestnuts. In the letter accompanying this specimen, dated December 15, 1915, Dr. Yamada says he found the specimen of *E. parasitica* on his first collecting trip after his return to Japan. In this connection it may be stated that during his recent visit to this country Dr. Yamada spent some time with the writers in examining specimens of *Endothia parasitica* and other species of *Endothia* and took back with him typical specimens. This probably accounts for his finding the fungus so quickly.

C. L. Shear,
Neil E. Stevens
Bureau of Plant Industry,
Washington, D. C.

THE AMERICAN SOCIETY OF ZOOLOGISTS. II

GENETICS

Sex Controlled in Rotifers by Food (illustrated by lantern): D. D. Whitney, Wesleyan University.

Several species from two of the five orders of rotifers have yielded very positive results. All female offspring were produced under certain food conditions and from 30 per cent. to 95 per cent. male offspring were produced under certain other food conditions. In some of the species the offspring were all females when the race was fed upon a diet of colorless flagellates, but when the race was suddenly put upon a diet of green flagellates a high percentage of male offspring appeared. In other species a scanty diet of green flagellates produced all female offspring while a

copious diet of the same green flagellates produced as high as 95 per cent. of male offspring, thus showing that it is the quantity of the food that regulates the production of the sexes and not the stimulus of a change of food.

Male-production in Hydatina Favored by Oxygen: A. FRANKLIN SHULL AND SONIA LADOFF, University of Michigan.

Whitney's experiments of a year ago, in which feeding these rotifers on the green flagellate *Chlamydomonas* resulted in greatly increased male-production, left room for doubt whether other agents than nutrition might not be producing part of the effects noted. The food cultures were differently constituted at the outset, and the organisms reared in them may have produced secondary differences. We have attempted to test some of the possible factors other than nutrition. So far our results may be interpreted largely in support of Whitney's conclusion; for, while one of the suspected agents has been found to increase male-production, its effect is not so marked as that in Whitney's experiments. The one effective factor discovered is oxygen. Under several different conditions, oxygen produced uniform effects of moderate degree.

On the Inheritance of Size in Paramecium: JAMES E. ACKERT, Kansas State Agricultural College.

A series of experiments with *Paramecium caudatum* and *P. aurelia* was carried on with a view to determining the effect of selection within the progeny of a single individual. In 1911, when these experiments were begun, the excellent work of Jennings had already been reported; but, to test this principle, independently, using large numbers of individuals, seemed justifiable. In a typical experiment a single *Paramecium* was isolated on a depression slide in a few drops of hay infusion. After several generations there were isolated from its descendants two *Paramecia*—one, the shortest of the progeny, the other, the longest. The descendants of each of these individuals were kept in separate receptacles under environmental conditions as nearly identical as possible. At a later time all but a few of the animals of each group were killed and measured. In all of the experiments, except one, the images of the *Paramecia* were thrown upon a screen with a combination microscope and lantern, giving a magnification of 3,200 diameters. The usual methods of dealing with statistical data were used in the preparation of the results. In all cases the effect of the selection within the progeny of a single individual was negative. In some instances the difference in mean lengths of the groups under comparison fell within the probable errors of the means; in others the mean lengths of the progeny of the smaller *Paramecia* were larger than those of the descendants of the larger *Paramecia.* The conclusion is based upon measurements of nearly 6,000 *Paramecia.*

The Influence of Selection on the Number of Extra Bristles in Drosophila: E. CARLETON MACDOWELL, Carnegie Institution of Washington.

Previously it has been shown that the extra bristles that characterize a certain race of *Drosophila* are conditioned by a Mendelian determiner; that the exact number of extra bristles is not inherited, but varies in relation to external conditions; that, in spite of this, the selection of high variates as parents, continuously raised the averages of the race for several generations, after which no further progress could be determined. The present report carries the selection for increased numbers of bristles to the forty-sixth generation. In certain of the later generations the averages have been raised by more favorable conditions and by counting only the large flies that hatch at the first of a bottle, the flies at the end of a bottle being smaller and with fewer bristles. The upper limits of the distributions would not be influenced in the same way, and so offer a better test for the effect of selection. These upper limits show no tendency to advance after the first few generations. Two series of return selections have been made, from the sixteenth and twenty-seventh generations. These failed to show any lowering of the averages, although carried on for six and eight generations, whereas the initial rise of the averages was immediate. The distribution of extra bristles extracted from a cross with normals is lower than that of the corresponding inbred generation. A race of low grade has been established from extras extracted from a cross. This race averages about two bristles lower than the high-selected race. If, as formerly proposed, the initial rise in the averages was due to a sifting out of secondary determiners, all the above results would be expected.

Twinning in Cattle, with Special Reference to the Free Martin (illustrated with lantern): LEON J. COLE, College of Agriculture of Wisconsin.

A study of 303 multiple births in cattle, obtained directly from breeders. The records include: 43 cases homosexual male, 165 cases recorded heterosexual (male and female), 88 cases

homosexual female, 7 cases triplets, a ratio of twins of approximately 1:4:2 instead of the 1:2:1 expected if there were no disturbing element entering in. The expectation may be brought more nearly into harmony with the facts if it is assumed that in addition to ordinary fraternal (dizygotic) twins there are numbers of "identical" (monozygotic) twins of both sexes, and that while in the case of females these are both normal, in the case of a dividing male zygote, to form two individuals, in one of them the sexual organs remain in the undifferentiated stage, so that the animal superficially resembles a female and is ordinarily recorded as such, although it is barren. The records for monozygotic twins accordingly go to increase the homosexual female and the heterosexual classes, while the homosexual male class, in which part of them really belong, does not receive any increment. This brings the expected ratio much nearer the ratio obtained.

Any female calf twinned with a male is referred to as a free martin. According to the interpretation given, some free martins should be fertile, while others are sterile. It was found that both classes exist.

CYTOLOGY

The Mitochondria in the Germ Cells of the Male of Gryllotalpa borealis: F. Payne, Indiana University.

The mitochondria are present in the spermatogonial cells in the form of granules lying at one side of the nucleus and between the nucleus and cell wall. In the early growth-period the granular appearance is replaced by a thread-like arrangement. The threads are grouped into a mass and lie in contact or near the nucleus. They remain in this position and condition throughout the growth-period. In the prophase of the first maturation division the threads come out of the mass and as the spindle forms they take up a position outside the spindle, but extending about half-way round it. The threads are almost as long as the spindle. After the chromosomes have reached the ends of the spindle the elongated mitochondrial threads seem to break near the middle, part of them moving along the spindle toward one pole and part toward the other. The threads seem to be approximately halved. In the second division a similar process takes place. Each spermatid, then, receives a mass of mitochondria. In the transformation of this spermatid into a spermatozoon the mitochondria take part in the formation of the tail, but nothing more.

Pairing of Chromosomes in the Diptera: Chas. W. Metz, Carnegie Institution of Washington. (Introduced by C. B. Davenport.)

A study of the chromosomes in about 75 species of Diptera, ranging from among the lowest to the highest in the order, reveals the following facts:

First, a paired association of chromosomes is found to exist as a normal condition in all species studied.

Second, the two members of each pair of chromosomes are homologous elements, of respectively maternal and paternal derivation.

Third, the association of homologous chromosomes into pairs occurs at a very early stage in ontogeny (before cleavage is completed) and persists throughout the larval, pupal and adult life of the fly.

Fourth, the paired association is found in all diploid cells, somatic as well as germinal.

Fifth, it apparently persists throughout all stages in the growth and division of each cell, being evident from earliest prophase to latest anaphase.

Sixth, to account for this side-by-side approximation of homologous chromosomes exhibited by the flies something more than purely mechanical forces must be taken into consideration.

The data indicates that pairing must depend upon the qualitative nature of the chromosomes. From this, and the fact that paired chromosomes are homologous chromosomes, the evidence is seen strongly to support the hypothesis that homologous chromosomes are qualitatively similar and that non-homologous chromosomes are qualitatively different in their make-up, and that therein lies the secret of Mendelian heredity.

Chromosome Individuality in Fish Eggs: A. Richards, University of Texas.

The observation of Miss Morris, that the chromosomes from the two parents can be recognized in *Fundulus* eggs fertilized with *Ctenolobrus* sperm is verified. Furthermore, even in the telophases of cleavage mitoses it is possible to recognize clearly the chromosomal vesicles as separate bodies, and in the resting nuclei the parts contributed by the individual chromosome can be distinguished without difficulty. Treatment of the eggs or sperm before or after fertilization by X-rays serves to emphasize this distinctness.

Studies on the Chromosomes of the Common Fowl (illustrated with lantern slides of photomicrographs): M. F. Guyer, University of Wisconsin.

My later studies, extending over a period of more than ten years, afford abundant confirmatory evidence of my earlier findings that in the spermatogenesis of the common fowl, a large curved chromosome, comparable to the sex-chromosome of other forms, typically passes undivided to one pole of the spindle during the division of the primary spermatocyte. To determine what form this element assumes in the somatic cells of male and female fowls, a study of the cells of embryo chicks was undertaken. In the main chicks of 10, 13 and 20 days of incubation were used. The cells studied were, for the most part, those of the developing nephridial tubules, the nervous system and the gonads. Two fairly well marked curved rods —easily discernible from the other chromosomes— were found to occur with great frequency in the cells of the male. A reexamination of spermatogonia of both the common and the guinea fowl revealed similar paired elements. In the female in a significant percentage of cases only a single element of like appearance could be found. Thus, for this element, the male appears to be homozygous, the female heterozygous. The large curved element of the primary spermatocyte would seem to be in reality, therefore, a double element formed by the fusion of the pair of curved chromosomes which exist independently in somatic and early germ-cells. However, the passing over of this element undivided in the first maturation division brings about a condition of dimorphism in the later male germ cells. An important point to be substantiated yet is whether one class of these degenerate without forming spermatozoa, or, if forming them, whether they are not sterile.

EMBRYOLOGY

Fish Hybridization an Instrument in Morphogenetic Research: H. H. NEWMAN, University of Chicago.

During the past ten years experiments in fish hybridization have engaged a considerable share of my attention and I have been strongly impressed with the possibilities offered by this field of experimentation. Practically any type of morphogenetic disturbance that has been obtained by physical or chemical means is duplicated in some common teleost hybrid. Certain crosses give all of the grades of optic anomaly described by Stockard and others as due to various anesthetics. Double-headed, double- and triple-tailed monsters, etc., are very numerous in some crosses and the genesis of these conditions could be readily studied in living material.

Among the most interesting anomalous conditions seen in these hybrids are the various disturbances in the relations of parts of the vitelline and systemic circulation. The heart and its main vessels frequently appear disjoined from the body, and exhibit an independence in differentiation and an automaticity truly striking. Many problems might be cleared up by a study of these conditions.

The various developmental blocks in hybrid crosses are of considerable general interest, especially to the experimental embryologist. The fact that the end of the cleavage period is the commonest block to hybrid development is significant in the interpretation of the physiology of cleavage and of gastrulation.

Other blocks such as those occurring during gastrulation, especially those involving disturbances of the mechanism of concrescence, are scarcely less significant.

Apart from hybrid results per se the hybridization method itself is of much broader application for experimental biology.

Structure and Function in the Development of the Special Senses in Mammals: H. H. LANE, University of Oklahoma.

By physiological experimentation upon the embryo and fetus of the rat and other mammals at different stages in their development, the time when each of the special senses—touch, equilibrium, taste, smell, hearing and sight—first becomes functional has been determined within relatively small limits of probable error, and a study made of the corresponding structural development. Considering a reflex arc involving any special sense, it has been found that the association centers, the afferent and efferent nerve-trunks, and the effective motor apparatus are all in working order before the special sense organ concerned is capable of functioning, *i. e.*, the organ of special sense is in each case the last link in the chain to be perfected, and in each case the function is established when (and only so soon as) the proper peripheral sense organ has reached its functional state. The order of development of the organs of special sense and their correlated mechanisms is not that demanded by a Lamarckian hypothesis. It seems evident from these investigations (which are being extended) that the development of the nervous system in general and the differentiation of its constituent parts are due not to *epigenesis*, but to *endogenesis*, or predetermination in the oosperm; that these structures appear not as direct responses to the needs of the embryo, but in anticipation of those needs; not under the influence of their spe-

cific, definitive environmental stimuli, but because of the inherited organization and forces in the oosperm, which can only be secondarily modified or controlled by other factors.

The Development of Recurrent Bronchi and of Air Sacs of the Avian Lung: Wm. A. Locy and Olof Lassell, Northwestern University.

The notable observations of Schulze (1911) and of Juillet (1912) have brought forward a newly recognized structural element—the recurrent bronchi—known only in the lungs of birds, which imparts a renewed interest in the structural peculiarities of the avian lung and in the physiology of its air-sacs. The development of these recurrent bronchi, beginning as buds on the air-sacs and growing into the lungs, as illustrated by the lantern slides, and the condition of the recurrent bronchi of the adult lung is shown by Wood's metal casts. The formation of bronchial circuits within the lung by the union of recurrent bronchi with branches of other bronchi is indicated, and the probable physiology of the air-sacs is briefly considered.

Regarding the development of the air-sacs, the interclavicular is shown to arise from four separate moieties, two from each lung, which later unite to form the single median sac of the adult. The lateral moieties of the interclavicular sac have long been recognized, but the existence of separate mesial moieties and the manner of the union of the four parts is believed to be presented for the first time.

COMPARATIVE ANATOMY

The Olfactory Organs of Lepidoptera: N. E. McIndoo, Bureau of Entomology.

The organs discussed in this paper are the olfactory pores, already described by the writer for the Honey Bee, Hymenoptera and Coleoptera in other papers. The present paper deals with only the morphology of these organs in Lepidoptera.

As usual, the olfactory pores are found on the legs, wings and mouth-parts. Two groups are always present on each trochanter; one group usually on each femur; a few scattered pores generally on each tibia, some of these sometimes being in the tibial spines; one to four groups on the base of each wing, besides scattered pores usually extending the full length of the wing; and a few pores on the mouth-parts.

The total number of olfactory pores varies from about 500 to 1,300. Moths usually have more pores than butterflies. Based on the total number of pores, the individual, sexual and specific differences are slight, while the generic differences may or may not be slight, the latter differences depending on the sizes of the specimens compared.

The olfactory pores are flask-shaped structures, and those on the wings have been called dome-shaped organs because the chitin surrounding each pore aperture is arched dome-like above the general surface of the wing. As usual, chitinous cones are present and the sense cells are spindle-shaped. In distribution and structure the olfactory pores of Lepidoptera are more similar to those of Hymenoptera than to those of Coleoptera.

The Structure of Agelacrinites, a Fossil Echinoderm (Cistoid) of the Richmond (illustrated with lantern): S. R. Williams, Miami University.

1. Agelacrinites was probably somewhat motile—at least able to adapt its peripheral rim to its surroundings.

2. The peripheral rim may have been extensible.

3. The animal probably breathed by muscular protraction, extension and retraction of the anal pyramid, getting oxygen by rectal respiration.

4. The probable path of the alimentary canal in the young animal.

5. Cover plates and floor plates of the brachial grooves and their patterns.

Neuromeres and Metameres: H. V. Neal, Tufts College.

The paper summarizes observations upon the nidular relations of cranial nerves in *Squalus* embryos and raises the problem, Are neuromeres reliable criteria of the primitive metamerism of the vertebrate head?

The motor nidulus of the trigeminus lies in the second and third hind brain neuromere (rhombomere); that of the facialis extends through four rhombomeres, viz., the fourth, fifth, sixth and seventh. The nidulus of the glossopharyngeus lies in the sixth and seventh rhombomeres, while that of the vagus extends from the posterior part of the seventh for a considerable distance in the unsegmented portion of the medulla.

Of the somatic motor nerves, the nidulus of the oculomotorius lies in the midbrain; that of the trochlearis lies primarily in the first (cerebellar) rhombomere; that of the abducens extends through the sixth rhombomere and somewhat into the two adjacent ones. The nidulus of the hypoglossus lies in the unsegmented portion of the medulla posterior to the seventh rhombomere.

Somatic motor niduli lie primarily dorso-lateral

to splanchnic motor niduli. Secondarily by migration (neurobiotaxis) these relations are reversed as in mammals (Graeper, '13).

The connection of four rhombomeres with a single visceral arch (the hyoid), and of three visceral arches with a single rhombomere (the seventh) is a fact not easily reconciled with the assumption that a single rhombomere was originally connected by a splanchnic motor nerve with a single visceral arch.

The Spines of Catfishes (illustrated with lantern): H. D. REED AND T. J. LLOYD, Cornell University.

The following observations upon the spines of catfishes were made chiefly upon the pectoral fins of *Ameiurus nebulosus* and various species of *Schilbeodes*, and are incidental to another study. In an attempt to determine the morphology of certain soft parts of the fins of catfishes it became obvious that there existed a definite relation to the morphology of the spines. A search of the literature revealed only such statements as "the spines are believed to represent a fusion of soft rays" rather than the ankylosis of the lepidotrichia of a single soft ray as in the true spiny-rayed fishes.

A study of the mature spines and developmental stages shows that the spines of the catfishes examined represent a fusion of several soft rays. The rays contributing to the formation of spines arise in the typical fashion and the fusion of rays as well as the lepidotrichia is from the base toward the free end. The cavity of the spine represents the distal (cephalic) half of the space found normally between the individuals of the fused pairs of lepidotrichia. The last ray, in young individuals, at least, is free for its distal half where it is segmented and bifurcates, as do the unmodified soft rays.

MISCELLANEOUS

A New Method of Observing the Bronchial Tree of the Embryonic Lung: WM. A. LOCY AND OLOF LASSELL, Northwestern University.

The difficulties of observing early stages of the bronchial tree of the embryonic lung are considerable. Wax reconstructions, celloidin injections and Wood's metal casts have unfavorable limitations.

A simple method is now available by the modification of a method of an injection originated by Hochstetter in 1898, for study of the semicircular canals of the ear. The lungs are dissected out of fixed and hardened specimens and cleared in thick cedar oil, after which they are immersed in a mixture of one part thick cedar oil and two parts chloroform. After thorough penetration, the specimen is removed from the mixture and placed on a filter paper until the chloroform evaporates. This serves to draw the cedar oil from the various branches of the bronchial tree and to fill the spaces with air. When the air-filled preparation is immersed in pure cedar oil the entire bronchial tree presents the appearance of being filled with a bright metallic cast and can be readily observed through the translucent walls of the lung. The minuter air passages are permeated, and, although the smallest ones disappear in a few minutes as the cedar oil percolates into them, the same specimen, if carefully manipulated, can be treated repeatedly without apparent injury. Results of this method are illustrated by lantern slides.

The Parasitic Fauna of the Bermudas: FRANKLIN D. BARKER, University of Nebraska.

The preliminary study of the animal parasites collected in the Bermudas during the summer of 1912 has been completed. A brief summary of the parasites found is as follows:

Parasite	Number of Species Found		Host
1. Protozoa	1		Toad
2. Trematoda			
A. Encysted	2		2 species of fish
B. Ectoparasites	2		9 species of fish
C. Endoparasites	44		23 species of fish
"	2		2 species of sea-cucumber
3. Turbellarias endoparasites			
4. Cestoda			
A. Mature	0		0
B. Immature (free)	2		6 species of fish
C. Immature (encysted)	5		14 species of fish
5. Nematoda			
A. Mature	3		7 species of fish
B. Immature (free)	3		10 species of fish
C. Immature (encysted)	2		5 species of fish
6. Acanthocephala	3		7 species of fish
7. Crustacea			
A. Copepoda	Undetermined		10 species of fish
B. Isopoda	Undetermined		5 species of fish

This study has been intensive for a comparatively small number of individuals rather than a superficial examination of a large number, with the result that the parasites found are all in first-class condition for detailed study. This has made it possible for us to add ten new species of trematodes, two new species of nematodes and one new species of acanthocephala to the large list of helminthes found in the fishes of the Bermudas and the Dry Tortugas by Linton (1908; 1910). We have also been able to add considerably to the meager descriptions of some species as well as to identify a number of Linton's undetermined species.

This and future intensive study of the parasitic fauna of the Bermudas has been made possible through the assistance of the Museum of Comparative Zoology of Harvard University and the Bache Fund of the National Academy of Sciences.

Increase in Opportunities for Work at the Bermuda Biological Station (illustrated with lantern): E. L. Mark, Harvard University.

By a recent agreement between the Bermuda Natural History Society and Harvard University, the Bermuda Biological Station for Research, which has hitherto been in operation for only six or eight weeks each summer, is now to be open throughout the year. Harvard has appointed Dr. William J. Crozier, resident naturalist and Mrs. Crozier, librarian and recorder. Dr. and Mrs. Crozier are living in one of the cottages on Agar's Island, where the station and the Bermuda Public Aquarium are located. The new arrangement will permit the investigation of classes of problems which could not be undertaken during a sojourn of a few weeks in midsummer, and will give opportunity to study seasonal variations as well as the times of fruiting and spawning. Not the least of the advantages resulting from this change is the opportunity it will give biologists to carry on work at a midocean station at any time of the year when they may choose to avail themselves of it.

The laboratory has accommodations for about a dozen investigators. It is not proposed at present to charge any fee for the privileges of the station. The purpose is to provide facilities for persons who are competent to carry on original work, and for such only; no instruction is offered; and the station is not to be used for the purpose of making miscellaneous collections of commercial value. The staff of the station will endeavor to procure and prepare at moderate cost material needed for investigations or for use in teaching.

Having completed the papers listed on the printed program, the following papers, received too late to be printed on the program, with the consent of the society were read:

The Cranial Nerves of an Adult Cœcelian: H. W. Norris, Grinnell College.

Two types: (1) Eye covered by the maxilla, eyeball very rudimentary, no optic nerve, no eye-muscle nerves, except abducens, no eye-muscles; (2) Eye not covered by maxilla, shows characteristic structure with nerves and muscles. Abducens in both innervates the retractor tentaculi muscle.

Lateral line components absent. Olfactory nerve apparently double, but actually merely exaggerating the condition found in other Amphibia. Two ganglia on trigeminal-nerve, as noted by previous writers. General cutaneous component in facial nerve, blending anteriorly with the trigeminal.

Previous writers (Marcus excepted) have represented posterior to the seventh and eighth nerves a complex with very puzzling characteristics. Resolved into its components this complex consists of: a ramus jugularis VII. that extends far back in the body to innervate the sphincter colli muscle; a sympathetic trunk, with two large ganglia, that has its origin in the gasserian and facial ganglia and reaches far beyond the posterior limits of the head; the IX.–X. nerve trunk with two distinct ganglia; an occipital nerve that passes through the posterior part of the first IX.–X. ganglion; the first, second and third spinal nerves, the first of which gives origin to the hypoglossal nerve, the second of which sends a branch through the second sympathetic ganglion, and the third of which sends a branch into the posterior tip of the same ganglion.

The Advancing Pendulum of Biological Thought: C. C. Nutting, State University of Iowa.

The figure of an advancing pendulum correctly represents the course of scientific progress. The alternate swings to right and left culminate in extreme positions, but the net result is a real advance.

The NeoDarwinian swing led by Weismann. Its extreme position and the net gain.

The NeoLamarckian swing led by the "American School." The extreme position of E. D. Cope and the net gain.

The Mendelian swing led by Bateson, Castle and others. The extreme position of Bateson. A biological justification of the theological doctrines of foreordination and regeneration. The net gain.

General principles deduced from this discussion.

The pendulum of thought never retraces its course; but there is regularly a net gain.

The extreme position, or furthest point of each swing, is almost invariably wrong.

Each leader contributes something real to progress, and it is unwise to utterly discredit him. Witness Morgan and pangenesis.

The return from the extreme of the Mendelian swing. Witness Castle and E. B. Wilson.

The position of the systematist under present conditions.

A Case of Sex-Linked Inheritance in Man: HANSFORD MACCURDY, Alma College.

In the history of a certain family in Michigan, there occurs a most interesting case of the transmission of a peculiar character, which manifests itself at the approach of maturity in a certain proportion of the males. It makes its appearance only after a long series of complex physiological processes and in a remote period of development. The factors are evidently not simple, and possibly may manifest themselves in various ways; but the particular character here noted affects the feet of males in a definite proportion.

An affected male does not transmit the factor or factors to his sons. He transmits them through his daughter married to a normal male through four out of five of his granddaughters, and through these to half of their sons.

According to the chromosomal hypothesis of control of development and heredity this is a case of sex-linked inheritance and is limited to one half of the sons of the daughters of affected males. It also indirectly points to the transmission of characters or factors detrimental to one sex.

The Components of the Cerebral Ganglia and Nerves of a 23 mm. Embryo of Squalus Acanthias: F. L. LANDACRE, Ohio State University.

The 23 mm. embryo of *Squallus* was selected because it is sufficiently developed to enable one to recognize the principal nerves and determine their composition while the ganglia are still fairly well separated so that their boundaries can be determined. The chief ganglia and nerves are found to be typical for Ichthyopsida in general. Some of the peculiarities noted are the very small size of oph. sup. V.; the separateness of the lateral lines organ primordia; the large size of the epibrachial placodes; the precocious character of the lateral line nerves as compared with other nerves. The analysis, which can be shown briefly only by means of a diagram, is offered tentatively in the absence of a published analysis of a more mature individual.

Silk Spinning in Its Relation to the Feeding Habits of Chironomus lobiferus Say: ADELBERT L. LEATHERS, Cornell University.

The larvæ of *Chironomus lobiferus* were found inhabiting the air cavities of the living stems of *Sparganium* sp., which they penetrate by boring two small openings through the epidermis. Here they maintain suitable living conditions by a regular undulating motion of the body which sets up a current of water through the burrow. An examination of the stomach contents showed the food to be plankton and not the tissue of the plant. It was found that these larvæ will adapt themselves to living in glass tubes, and under such conditions careful observation revealed a conical net fastened at the base to the silken lining of the larval gallery and held extended by radiating threads attached to its apex. This net is made to bulge out by the pressure of the current forced into it. The smaller particles become tangled in its meshes and the protozoa, diatoms and other unicellular algæ are largely removed, although some escape through gaps near the rim of the net. When this current has been maintained for about ten minutes, regardless of the amount of food in the net at any time, the larva turns about in its burrow and grasps one edge of the net and forces it into its mouth, then rotates its body and grasps another part, and so on until the net is entirely swallowed. Then it spins another, spreading and attaching the silk by its anterior prolegs; turns about and begins the undulating motion again.

The Resistance of Starved and Normal Fishes to Low Oxygen and the Effect upon this Resistance of Acids, Alkalies, Salts, Etc.: MORRIS M. WELLS, University of Chicago.

The resistance of normal fishes to various concentrations and combinations of oxygen and carbon dioxide was determined in 1913 (*Biol. Bull.*, Vol. 25) and since that time an improved apparatus has been devised and the resistance of starved fishes at different periods during the starving process has been determined. The work is being pushed further in an attempt to determine the relation of the oxidations of the fishes to the presence of other substances in the water. The effects of acidity and alkalinity have been compared, the dying time in running and stagnant water has been determined and the work that is now under way contemplates the determining in the next three weeks of the effect upon the resistance of the fishes of the presence of various salts and sugars, and a comparison of the effects of KCN as compared with low oxygen.

Results already obtained:

1. An apparatus that will furnish a flow of about one liter of oxygen-free water per minute.

2. A determination of the seasonal resistance of fresh-water fishes to low oxygen.

3. The resistance curve of starving fishes which live without food for three to four months. This curve shows a rise in the resistance of the fishes, *i. e.*, a decrease in their susceptibility, during the first part of the starving period; this increase in resistance lasts for from three weeks to two months and then the resistance usually falls off very rapidly and the fish soon dies of starvation.

4. The rate of actual loss of weight in starving fishes has been determined by consecutive weighings, and a comparison of loss of weight and its effects upon resistance in young and old fishes has been made.

5. It has been determined that the reaction of the water, *i. e.*, whether alkaline or acid, has a marked effect upon the resistance of the fishes and the alkaline water seems to be considerably more toxic than the acid in such small concentrations as *N*/3,000 or thereabouts.

6. When the water is alkaline fishes live longer if corked up in the low oxygen water than they do if the water flows constantly through the experimental bottle.

It is expected that some further data will be ready for discussion by the time of the Christmas meeting, as the experiments are being run daily.

Chromosomes in Relation to Taxonomy in the Tettigidæ: W. R. B. Robertson, University of Kansas. (Introduced by B. M. Allen.)

Experimental Modification of the Development of the Germ Cells of Rana: B. M. Allen, University of Kansas.

Compound Chromosomes in Charthippus curtipennis: W. R. B. Robertson, University of Kansas. (Introduced by B. M. Allen.)

Exhibits

The society adjourned, after its session for the transaction of business, on the afternoon of Wednesday, December 29, to examine and discuss the following exhibits which had been arranged in the bacteriological laboratory on the second floor of the Veterinary Building:

Elementary Color Patterns and Their Hybrid Combinations in Grouse Locusts, Robert K. Nabours, Kansas State Agricultural College.

Photographs Illustrating (I) *Experimental Alteration in the Direction of Growth of a Silicious Sponge* (*Stylotella heliophila* Wils.), (II) *Pseudopodia in Sponge Plasmodia Formed from Dissociated Cells,* (III) *Canals and Pores that have Developed in a Sponge Plasmodium,* H. V. Wilson, University of North Carolina.

In the common type of this sponge there is a basal body produced upward into vertical lobes bearing oscula at the summit. If such a sponge be laid on its side, the original oscula gradually close and disappear, while new vertical lobes grow up toward the surface of the water, at right angles to the original lobes. The new lobes bear oscula at the summit.

Wood's Metal Casts of the Recurrent Bronchi of the Adult Lung of the Chick, Wm. A. Locy, Northwestern University.

Sections Showing Pairing of Chromosomes in the Diptera, Charles W. Metz, Carnegie Institution of Washington.

(1) *A Portable Diagram Holder,* (2) *Laboratory Dissecting Pan,* E. L. Mark, Harvard University.

Model of the Pectoral Spine of Ameiurus, H. D. Reed, Cornell University.

Charts and Specimens Demonstrating the Nature of the Intercellular Connective Tissue Substance, Raphael Isaacs, University of Cincinnati. (Introduced by H. McE. Knower.)

Slides for Demonstrating Chromosomes of the Common Fowl: M. F. Guyer, University of Wisconsin.

Symposium

At the session held during the forenoon of Thursday, December 30, a symposium on the topic "The Basis of Individuality in Organisms," was held, C. M. Child, O. C. Glaser and H. V. Neal reading papers, the first speaker approaching the problem from the point of view of the physiologist, the second from that of the physical-chemist, the third from that of the vitalist. Illness in the families of E. G. Conklin and C. E. McClung prevented their attendance. The paper prepared by E. G. Conklin was in the hands of the secretary, but, for want of time, it was not read. It was evident that those who took part in the symposium had given much time and thought to the subject and in the preparation of their papers[1] and a vote of appreciation of their efforts to make the meeting a profitable and enjoyable occasion was voted by the society, and then adjourned *sine die.*

Caswell Grave,
Secretary-Treasurer

[1] It is hoped that these papers will be published in Science during the year.